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THE EVOLUTION OF HERBS

THE most ancient system of botanical classification which we know, first proposed by Aristotle and Theophrastus and even continued after the dawn of modern botany with the herbalists of the sixteenth century, divided all plants into three great and easily distinguishable groups, the trees, the shrubs and the herbs. As time went on, however, and as botanical knowledge grew more and more thorough, it became evident that any system of this sort, based simply on the habit of growth, not alone brought together many plants unrelated in almost every respect but separated others which clearly resembled one another in most of their characters. The old classification was therefore gradually abandoned and in its place grew up various systems in which an attempt was made to gather plants into more natural groups. Finally the theory of evolution, with its emphasis on actual genetic relationship as the basis of all sound classification, gave a great incentive to the building of hypothetical family trees and lines of descent in the vegetable kingdom. Almost all of these have been founded mainly on a comparative study of the various floral parts; and it is therefore with such structures that modern students of the morphology and taxonomy of plants have for the most part concerned themselves. The various types of growth habit, those most evident and striking of plant characters, so much emphasized by the earlier botanists, have consequently been largely neglected as being too variable and too dependant on a changing environment to be of much use in determining actual relationships.

But however valueless an inquiry which concerns these more conspicuous distinctions may be in tracing outlines of descent and determining the evolution of *flora*, it does provide us with important information as to the origin and development of plant forms, the evolution of *vegetation*. In many ways this knowledge is of more importance than the construction of family trees alone, for it is more often the growth habit of plants rather than their systematic position which is correlated with the climatic, geological and zoological factors in their environment. Indeed, to man himself the distinction between an herb and a tree is frequently of greater economic significance than that between two families of plants.

Investigations on this problem of the evolutionary history of growth forms among the higher plants has produced evidence from various sources that in comparatively recent geological time there has been a radical change in the character of much of the earth's vegetation, perhaps the most important one since the appearance of the angiosperms; a change produced by the origin and wide dispersal of those lowly but numerically abundant, quickly maturing and rapidly spreading plants, the herbs, in a vegetation which seems to have been previously composed almost entirely of trees and shrubs. Light has also been thrown on the factors which were responsible for the development of this new plant type and on the far-reaching changes which its introduction has caused in the history of plants, animals and man.

In any such problem of evolution as this we naturally turn first to a study of the fossil record. Of course the very earliest of land plants, if our present theories are correct, were delicate semi-aquatic species, probably resembling our modern liverworts, plants which from their essentially herbaceous structure failed entirely of preservation. As to the development of these lowly forms into the vigorous and land-loving vascular plants which are now so completely dominant we know almost nothing, either from the geological record or from the occurrence of intermediate types. The luxuriant vegetation of the latter part of the Paleozoic, which gave us our first fossil plants, was composed of various ancient types of ferns, lycopods, horse-tails, cycad-ferns and gymnospermous seed plants. It is significant that although nearly all of these were either trees or stout woody forms, their representatives which have been able to survive to the present time have with few exceptions been reduced to such an herbaceous stature as characterizes our ground pines, horse-tails, quillworts and ferns to-day. Among the angiosperms, which occur as fossils only since the lower Cretaceous, a similar change seems to have occurred for nearly every one of the early fossil members of this great group were apparently woody plants. Of course it must be borne in mind, as in all such cases, that the geological record may not present us with a fair sample of an ancient flora; for the leaves of woody species would in general be much more favorable for preservation than the more delicate ones of herbaceous plants. As far as it goes, however, the geological evidence tends to indicate that among vascular plants, at least during the period covered by the earlier fossil record, woody forms were the dominant type of vegetation.

The labors of the botanical taxonomists have also provided us with a valuable clue as to the history of growth habits, particularly among the angiosperms. This now dominant race is generally agreed to have descended either from cycad-like types or from forms related to the conifers. Both

of these groups are to-day (and seem always to have been) composed entirely of woody plants. Furthermore, although opinion is still divided as to which of the living angiosperms are the most ancient, it is generally agreed that this distinction belongs either to the naked-flowered, catkin-bearing types grouped together as the Amentiferæ, or to the complete but simple-flowered Ranales. The former are almost exclusively trees or shrubs to-day and the latter are predominantly so, making it probable that the angiosperms at their inception were woody in character. Moreover, in cases where a particular genus, family or order contains both woody plants and herbs and where it is possible, on evidence from other sources, to determine which members are primitive and which are more recent, it is found in practically every instance that the woody forms are more ancient in type than the herbaceous ones. This is well illustrated in the Leguminosæ. Here the two most primitive sub-families, the Mimosæ and Cæsalpineæ, are almost exclusively woody, practically all the herbaceous forms being included in the obviously less ancient Papilionatæ. Evidence derived from a study of plant descent therefore also indicates the greater antiquity of the woody type of vegetation.

This conclusion again receives confirmation from a study of the anatomical structure of woody plants and herbs, for in the latter the various elements of the wood—the vessels, rays and parenchyma—are often widely different from their primitive condition as we see it in admittedly ancient types of vascular tissue, and have evidently undergone much modification and specialization.

The distribution of these various growth types over the globe to-day is of expectional interest in providing us with evidence not only as to their relative antiquity but as to the factors which have caused the change from one type to the other. The most striking fact which such an investigation establishes is the overwhelming predominance (in number of species) of herbs in temperate regions and of woody plants in the warmer parts of the earth. In Table I. are shown the numbers and percentages of herbaceous species in the floras[1] of nineteen typical regions.

TABLE I

	Total Species	Herbaceous Species	Per Cent. Herbs
Ellesmereland	76	71	93
The Faroes	164	150	91
Switzerland	1,899	1,726	91
Iceland	221	200	90
Great Britain	927	821	89
Rocky Mountains	2,206	1,910	87
Russian Empire	14,704	12,588	86
Germany	1,117	947	85
Spain	4,481	3,554	79
Northern United States	2,662	2,089	78
Japan	3,257	1,861	57
Florida Keys	415	225	54
Tropical Africa	8,577	3,560	42
Hongkong	728	293	40
Ceylon	1,793	670	37
British West Indies	2,249	675	30
Java	3,188	867	27
Brazil	15,981	4,092	26
Lowlands of the Amazon Valley	2,209	265	12

It will be noted that in the tropics only about ten to forty per cent. of the species are herbaceous, but that as we go into cooler regions the proportion of such plants greatly increases until in arctic and alpine areas they constitute ninety per cent. or more of the flora. Of course these figures do not mean that the *vegetation* of temperate regions is mainly herbaceous. Forests, indeed, are well developed there, but they are composed of only a few hardy families of trees; whereas in the tropics almost every family has numerous woody representatives. The tropical floras analyzed included in almost all cases many plants

[1] In these analyses dicotyledonous plants alone are considered.

from cool upland or mountain regions, where herbs are commoner than in lowlands, and the herbaceous percentage is accordingly higher. In the lowland tropical forest, however, as is shown in the selected figures for the Amazon Valley only, herbaceous species are extremely few.

The most important limiting factor to the spread of tropical vegetation seems to be the occurrence, even for a very short time during the year, of temperatures near the freezing point. As to just what the climate was like under which the angiosperms first appeared we are not altogether certain, but freezing temperatures seem for the most part to have been quite absent. We may reasonably infer that conditions then favored an overwhelming development of trees and shrubs such as we see in winterless regions of the earth to-day.

An examination of those floras which are believed to be very ancient and to be composed of plant types which have elsewhere disappeared, is of especial interest for our problem. The organic life of certain isolated oceanic islands, in particular, is generally recognized as giving us a rough idea of the fauna and flora which existed over wider areas in ancient times; and the "endemic" animals and plants—those which are peculiar to the region and are found nowhere else, and which in such oceanic islands constitute a large proportion of the species—are regarded as still more ancient than the non-endemic element; for they must either have had a long evolutionary history in the region or must be remnants of older types which have elsewhere become extinct. Table II. shows the percentage of herbs among the non-endemic species (most recent element); the endemic species of non-endemic genera (intermediate element); and the species of the endemic genera (most ancient element) in certain of these insular floras.

TABLE II

	Recent Element, Per Cent. Herbs	Intermediate Element, Per Cent. Herbs	Ancient Element, Per Cent. Herbs
Hawaii (582 species)	76	21	9
Fiji (563 species)	26	2	0
Juan Fernandez (89 species)	94	27	0
St. Helena (41 species)	73	32	0
Socotra (517 species)	85	26	9
Mauritius and the Seychelles (587 species)	59	16	5

It is evident that the youngest element is predominantly herbaceous, the intermediate one less so, and the oldest almost entirely woody. In fact, the great majority of herbs in these insular floras apparently arrived such a short time ago that they have not yet developed into endemic types, but are still identical with species in other regions. This is the more noteworthy since herbs, because of the brevity of their life-cycles and their consequent multiplication of generations, tend to change more rapidly than woody plants. The vegetation of these ancient islands thus seems to have been, in times not very remote, even more devoid of herbs than it is at present. In such islands as Bermuda and the Azores, on the contrary, where from the almost complete absence of endemic species we have reason to believe that the flora is not ancient, the percentage of herbs is fully as high as in continental areas of similar climate.

The larger land masses of the south temperate zone—Australia, New Zealand, southern South America and South Africa—which have also been isolated in a greater or less extent from the continental areas of the northern hemisphere, resemble ancient oceanic islands to a certain degree in the composition of their vegetation. In Table III. are shown the percentages of herbs among the species of the non-endemic genera (recent) and among the endemic genera (ancient) in the floras of these regions.

TABLE III

	Recent Genera, % Herbs	Ancient Genera, % Herbs
Australia (5,711 species).....	62	17
New Zealand (1,026 species).....	81	20
Southern South America (1,587 species).....	87	48
South Africa (7,984 species).....	58	30

Here again, though not to as marked a degree as in insular floras, the more ancient element is predominantly woody and the more recent predominantly herbaceous.

It is noteworthy that there are many species of plants in the ancient insular floras which are identical or nearly identical with species on widely distant oceanic islands or on ancient continental areas, a fact which strengthens our belief that the vegetation of these regions is a remnant of one which was formerly much more widely spread.

If the herbaceous element in the vegetation of such isolated regions as we have described is entirely or in great part of recent arrival, we naturally look for its seat of origin to the extensive land areas of the north temperate zone where herbs to-day reach such high development, and where so many new types of animals and plants have had their birthplace. Even here there is evidence that the woody element in the vegetation was at one time much more diversified and prominent than at present, for very many genera and families of trees and shrubs are found here as fossils from the Cretaceous and Tertiary which are absent from the living floras. This is particularly true of Europe, where there are to-day so few species of woody plants.

These facts—that woody plants are more ancient than herbs as shown by evidence from fossils, from natural relationships and from anatomy; that herbs are now dominant and woody plants few in species in regions subject to low winter temperatures, and *vice versa;* that regions which have been isolated from the north temperate land mass possess few herbs in the ancient portion of their floras, and that the northern continents supported at no very ancient date a much more varied woody vegetation than at present—all suggest the conclusion that a large portion, at least, of our modern herbaceous vegetation originated in the north temperate zone in response to the progressive refrigeration of climate which we know to have taken place there during the Tertiary.

The great advantages conferred by the possession of an herbaceous habit of growth in a region subject to low winter temperatures are obvious, for such plants are able to complete their cycles and to mature seed in the warm summer months and can then survive the cold of winter in the form of resistant seeds or by hibernating underground. Only the hardier types can maintain permanent aerial stems under these conditions. The more delicate woody families have either been exterminated outright in temperate regions or have survived only by assuming an herbaceous habit and thus flourishing in that part of the year which is free from frost. As might be expected if low temperature has indeed been the determining factor in the development of herbs, most of those families which are well able to survive cold as trees or shrubs and which form the bulk of the woody vegetation of the north temperate zone—the willows, birches, oaks, beeches, walnuts, hickories, wax myrtles, elms, hollies, maples, heaths, buckthorns, lindens, planes, sumachs, cornels, and viburnums—are families which are almost entirely without herbaceous members. Being hardy, they have not been forced to adopt the herbaceous habit.

As to the details of this change in growth habit we can not of course be sure, but in those forms which it did not kill outright

the increasing cold probably effected a gradual reduction in size and an attendant shortening of the time necessary to reach maturity, until very dwarf forms were produced which were able to develop from seed to seed in a year or two, and which could be killed back to the ground every winter—in short, perennial herbs. The herbaceous vegetation in arctic and alpine regions to-day is still composed almost entirely of such plants. The annual herb seems to have developed from this primitive type under more favorable environments, where a plant growing from seed, and thus without a subterranean food reservoir to give it a rapid start, could become large enough in a single season to reproduce itself.

The northern vegetation thus developed proved extremely hardy and aggressive, and was able not only to overspread the great continental area of the north temperate zone but to invade as well the tropics and even the Antipodes. The presence of a large number of typically northern genera of plants in Australasia, southern South America and South Africa, often separated from their related forms by the whole width of the tropics, has long been recognized as one of the most fascinating problems of plant distribution. It is important to note that this invasion of northern plants (nearly 200 genera are known) which has been so successful in penetrating far southern regions and which displays so well the "wonderful aggressive and colonizing power of the Scandinavian flora" to which Wallace and others have called attention, has in reality been an invasion of *herbs,* for almost none of the northern trees and shrubs have participated in it.

Herbaceous plants have also been developed in the south temperate zone apparently in response to the refrigeration of climate there in the late Tertiary. Antarctic herbs were doubtless among the very last plants to leave the polar continent as the glaciers advanced. They are still almost all alpine or cold-loving perennials and have as yet failed to give rise to the aggressive lowland annual type.

Refrigeration of climate was doubtless not the only factor in the development of an herbaceous vegetation. A large body of such plants seem to have originated in arid regions, where they spring up rapidly and produce seed during a rainy season, thus bearing precisely the same relation to extremes of moisture that arctic or alpine herbs do to extremes of temperature. The assumption of a rapidly climbing habit, especially in the tropics, has also resulted in the development of an herbaceous type of stem in such families as the melons, milkweeds and passion-flowers.

But whatever the cause of their origin, herbs have proved themselves an exceedingly versatile and aggressive type of vegetation under almost all climatic conditions. The reasons for this dominance of the herb are not far to seek. It is able not only to thrive in cold and arid regions but, from the brevity of its life-cycle, can take advantage of temporarily favorable conditions of any sort. Its evident and great superiority over woody plants in rapidity of dispersal and ability to invade new areas quickly is due in large measure to the fact that its interval from seed to seed, instead of being many years, is only a few months. Every seed may itself become a center of dispersal in a season's time. The amount of seed produced, too, in proportion to the bulk of plant body which has to be developed is far greater among herbs than among woody forms. Owing to the rapid multiplication of their generations herbs are capable of more rapid evolutionary change than are trees or shrubs and hence are able to adjust themselves more rapidly to new conditions.

With these various advantages it is not surprising that the herbaceous habit to-day characterizes not only great numbers of the commonest and most dominant native plant species in all parts of the world but also that huge array of hardy and ubiquitous plants which we know as weeds.

This radical change in the growth habit of many plants from a woody to an herbaceous type which has taken place for the most part since the beginning of Tertiary time cannot have failed to exert an important influence on animal life. It may well be connected with the rapid evolution of mammals which we know to have occurred after the early Tertiary. To quote from Chamberlin and Salisbury:

> The earliest Eocene mammals were much more primitive and obscurely differentiated than even those of the middle Eocene, and this rapid backward convergence seems to point to some set of conditions which caused an exceptionally rapid development of the great class at this stage, whatever their previous history had been. The coming into a new domain of rich and varied conditions, whether by immigration or indigenous development, may be safely included among those conditions.

Is it not reasonable to suppose that the appearance of a great body of herbaceous vegetation just at this time was one of these conditions? This would affect directly the development of all herbivorous types and indirectly of many others. In the evolution of the tooth of the herbivora, indeed, we can trace the change from a sharply cusped type, suitable for chewing tough leaves and twigs, to the modern flat condition which is capable of dealing only with the softer herbaceous tissues.

The development of herbs was also apparently of some importance in the evolution of bird life, for the appearance of an immense new food supply produced by this terrestrial, seed-bearing vegetation, must certainly have led to the much greater abundance of such ground-loving types as the finches and others, and may well have been responsible for their origin. So closely are plants and insects related, too, that a radical change in the one can not have been without effect on the other.

Far more important, however, is the part which the herb has played in the development of human civilization. Primitive man seems to have been mainly arboreal in his habits, or at least primarily a forest dweller, and the wood, bark and fruit of trees and shrubs were of supreme importance to him as sources of shelter, fuel, implements, clothing and food. One of his first steps from this barbarism toward civilization was to enter the open and begin the practise of agriculture. Those plants which most commended themselves to the earliest tillers of the soil were probably not the slow-growing trees and shrubs but rather the herbs, since the rapidity with which they grow and reach maturity makes possible their culture even among such roving tribes as were our North American Indians. Only as man acquired a settled place of abode and a more permanent form of society could he begin the culture of woody plants in orchard and vineyard; and it is only in very recent times that agriculture has extended beyond these fruit-bearing trees and shrubs and, in the form of forestry, has begun to treat timber trees themselves as a crop to be cultivated.

The marked superiority of the herb in ease of agricultural manipulation, together with the wide variety of uses of root, stem, leaf and fruit, have given it an increasingly high place in man's favor. To be sure, trees and shrubs provide us with timber, fuel, paper, rubber, fruits, nuts, coffee, tea, cocoa, vineyard products, turpentine and many drugs and items of lesser consequence. Among herbaceous products, however, are found all the cereals and vegetables, together with sugar, tobacco, most

of the fibers, certain of the fruits, and very many other valuable commodities. In addition to all this, the animal industries, which are the sources of milk, meat, leather and wool, are dependent entirely upon herbs. The dominance of such plants in agriculture is shown by the fact that in the United States they contribute 96 per cent. of the value of the products of this fundamental industry. Without herbs, the feeding and clothing of our great populations to-day would be quite impossible, and though it is conceivable that with the advance of science civilized man might possibly dispense with woody plants, in the absence of herbs he would perforce revert almost to savagery again. Human society is essentially an herbaceous product.

Although a study of the evolution of growth-habits may not provide much information as to the natural relationships of the higher plants, as we remarked at the outset, it does nevertheless introduce us to a momentous chapter in the history of the vegetable kingdom, for these lowly forms have not only possessed the earth and determined the character of many types of animal life, but to their indispensable aid man himself really owes his career as a civilized being.

Edmund W. Sinnott
Connecticut Agricultural College

CONTRIBUTIONS OF CHEMISTRY TO THE SCIENCE AND ART OF MEDICINE[1]

At the last two meetings of this Society the general sessions have been devoted chiefly to symposia upon the contributions of the chemist to the varied phases of our American industrial development. Such emphasis is both timely and well merited. But I am impressed that this record of achievement should not be closed without some consideration of the contributions of chemistry to the science and useful art of medicine. The opportunity seems likewise propitious for some suggestions as to means by which future contributions in this direction may be increased in number and in value.

The *science* of medicine consists in the knowledge of the normal processes of the human body (physiology) and of the nature and causes of abnormal deviations (pathology). The *art* of medicine includes the prevention of such deviations (hygiene), their identification (diagnosis) and their correction or alleviation by therapeutic or surgical treatment. For its present state of development each of these branches owes much to the contributions of chemistry.

Since Lavoisier's demonstration of the identity of respiration with combustion the chemist has gone step by step with the physiologist in elucidating the normal operations of the first internal combustion engine. Chemical structure of inanimate carbohydrates, lipins and proteins sheds reflected light upon the reactions and structure of living protoplasm. Colloidal chemistry, catalysis and the laws of chemical dynamics furnish all that we know of those servants of the cells, the enzymes. A new constituent of the blood is recognized to-day and to-morrow we have a new theory of metabolism. Thermochemistry is the foundation of nutrition and dietetics. The occultism of biogenesis, growth and the internal secretions is giving way before the calorimeter and the differential equation. In a word, the whole datum of physiological chemistry is a contribution to physiology and hence to the science of medicine; that much of it yet lacks practical application is no discredit to the contributor.

So much yet remains to be done in the field of chemical pathology that we are sometimes inclined to disparage past achievements. But these are not inconsiderable. In edema, concretions, diabetes and other conditions of acidosis, pathological variations in metabolism in fever, and in numerous other directions substantial gains have been recorded. Uric acid

[1] Presented to the Division of Biological Chemistry of the American Chemical Society at the spring meeting at Champaign, Ill., April 17–21, 1916.

has been found not guilty of most of the offenses charged in the earlier indictments—and part of the responsibility for gout must be borne by as complete a chemical abstraction as tautomerism. But, by all odds, the greatest progress in the field of pathology is the widening recognition that in the future the important advances must be made by the chemical rather than by the histological route.

These contributions of chemistry to the science of medicine are for the most part distinctly modern. Far earlier were many of those to the *art*. Paracelsus gave chemistry a practical object as it emerged from the clouds of alchemy when he declared that "the object of chemistry is not to make gold, but to prepare medicines." In England, to-day, the drug store is the "Chemist's Shop," and those are not lacking in this country to whom the term chemist has a similar significance. Both are the spontaneous acknowledgment of the services of the chemist in supplying these tools of the physician. For if Paracelsus, Franciscus Sylvius and their followers of the iatrochemical school failed in their effort to develop chemistry simply as an adjunct to medicine they planted the seed which through many generations have brought forth Liebig's chloral, Ehrlich's salvarsan and the host of other synthetics which make up most of the materia medica of to-day.

The development in synthetic drugs which has followed the recognition of a connection between chemical structure and pharmacological action is a fascinating story; less, possibly, on account of actual results than because of the tantalizing probabilities. But with the establishment of the definite effects of at least some configurations and a measurement of the mutual influence of different radicals have come practical results. Guided by this information, old remedies have been improved by blocking the groups responsible for secondary effects or entirely replaced by better ones constructed to specifications. At the same time experimental pharmacology has been stimulated with the result that the modern physician has at command, for producing almost any desired effect, a variety of drugs of great reliability.

But internal therapy does not exhaust the resources of treatment and if synthetic chemistry has done much for the former it has done still more for surgery and the surgical specialties. Anesthesia and asepsis are the pillars of these structures—and the stones of the pillars are the synthetics ether, chloroform, iodoform.

Strangely enough, diagnosis is the last branch of medicine to which applied chemistry has brought substantial benefit. To be sure we have had for many years an attempt at diagnosis by means of qualitative tests.[2] The urinalysis consisting only of qualitative tests for sugar and albumin is worth just as much as the feel-your-pulse, see-your-tongue, give-you-calomel variety of clinical diagnosis and treatment—just as much and no more. The essentials of progress may be a slow and steady growth, but the results usually appear by spurts and in response to some particular incentive. In this case the impetus was furnished by the new methods of blood and urine analysis, introduced by Folin and his co-workers, which in a short time have found such wide application. Nitrogen partition in the urine and retention in the blood; urobilin index of erythrocyte destruction; differentiation and prognosis in renal and cardiac conditions; sugar and acetone elimination in diabetes; hydrogen ion concentration of the blood in other conditions of acidosis—these are but types of the applications of quantitative chemistry to clinical diagnosis. Scarcely a month in which the journals fail to report another.

In this résumé no claim is made to completeness—still less to originality—of data. But it is hoped that from a somewhat panoramic view there may be caught a conception of the truly basal relationship of chemistry to medicine. It is for this collective concept that I bespeak the consideration which it has received of few chemists and still fewer physicians. To be sure, chemistry has long occupied a more or less perfunctory position in the curricula of medical colleges—becom-

[2] "As long as only qualitative methods are used in a branch of science, this can not rise to a higher stage than the descriptive one. Our knowledge is then very limited, although it may be very useful." —*Arrhenius.*

ing rather more than less perfunctory as the actual preparation of medicines, its most clearly recognized application, passed out of the hands of medical men. And chemistry is one of the subjects in which examination is required by official licensing boards. But it would require a most gifted intelligence to be able to deduce from the adventitious subject-matter of most of these examinations any suggestion that chemistry is a fundamental part of medicine rather than some extraneous attachment.

Let me explain what I mean by perfunctory position in the medical curriculum. Until the very recent general upheaval, medical instruction in all branches left much to be desired (to be conservative in expression). Rather than an exception to this statement, the old so-called "medical chemistry" was a glaring case in point. Crowded with descriptions of natural occurrences and methods of preparation of drugs, indications, effects and dosage, clinical symptoms of poisons and their laboratory detection—so much was usurped from the provinces of pharmacy, materia medica, pharmacology and therapeutics that little space was left even in the ponderous "Textbooks of Medical Chemistry" for references to fundamental chemical principles. When included at all these latter were carefully segregated within the paragraphs of their original mention—paragraphs which could be omitted quite as easily as those on the oxides of iodine without impairment to the continuity of the text. And in practise it would appear that these paragraphs on chemical principles were omitted with even greater facility.

We may well congratulate ourselves that "all that's put behind us," far away if not long ago. Instruction in chemistry in the medical colleges is now exclusively in the charge of full-salaried teachers, most of whom are trained chemists. Matters extraneous to chemistry are no longer allowed to preempt the place which belongs to the fundamentals of chemical theory and the present-day courses in chemistry, as given in most medical colleges, are of quite the same degree of excellence as those in other professional or academic institutions.

It is satisfying to regard this improvement, but facts are not wanting which raise other questions. May we still be lacking somewhat of the highest possible efficiency? In the Standards of the Council of Medical Education of the American Medical Association, defining the "Essentials of an Acceptable Medical College," this dictum is laid down, "Non-medical men should be selected as teachers in medical schools only under exceptional circumstances and only because medical men of equal special capacity are not available." The obvious advantage sought is the wider point of view of men trained to the practical applications of their subjects to other branches of medicine and able to direct the minds of students to these interrelationships. There is no department of instruction in which this advice of the Council has been so consistently disregarded as in the selection of chemistry teachers—and for the very good reason indicated, that "medical men of equal special capacity" were not (and are not) available. Medical instruction in chemistry is, therefore, for the most part in the hands of men adequately enough trained in chemistry but without formal education in medicine. As one of that very class, I venture to raise the question as to whether we have always sufficient catholicity. Is it not possible that we sometimes overlook the fact that we are training men to be physicians, not chemists? In our very righteous indignation at the inefficiency of the old "medical chemistry" may we not have swung the pendulum a little too far away from the point of practical contact?

To the last question it may be replied with perfect logic that when we have laid an adequate foundation of sound theory it is for the physiologist, the pathologist and the internist to build upon it according to the particular needs of his subject. But, like the gas laws, this logic applies strictly only under ideal conditions. As a practical fact the pathologists, internists, etc., concerned are not infrequently men who have succeeded less on account of any knowledge of chemical principles than in spite of the handicap of their inadequate instruction in that subject. Most of us have known chemists, the great men of a passing

generation, who having passed middle age before the advent of certain theories were entirely unable to use them in their reasoning although according formal acceptance. It were hardly fair to prescribe a more rigid requirement for our medical teachers of the present, though we may expect much more of those now in the making. In the meanwhile, shall the student be allowed to miss much which is essential because the chemistry teacher prefers to draw about himself the white mantle of pure science and pass by on the other side?

Another question occurs. By inference there has already been suggested a need for teachers trained both in chemistry and in medicine. The large number of published researches by "John Doe, Ph.D., and James Smith, M.D." suggests another field of usefulness for the man who can unite the training indicated by these two degrees, while the increased application of chemical analyses to clinical diagnosis is a third factor in creating a demand for such preparation. The last factor is worthy of some special consideration. This increased demand for chemical data in diagnosis is already marked, but it has only commenced. There must be men to do the work—and the practician is excluded. The methods concerned are quantitative and their usefulness depends upon the accuracy of the results. Even assuming the possibility of developing a quantitative conscience in a medical student within the available time, analytical efficiency can not be maintained by sporadic efforts—and the maintenance of regular quantitative work is incompatible with the practise of medicine. The requisite skill can be provided only by chemically trained men who give it their regular attention, and this is the way it is actually working out. The movement toward concentrating medical practise in hospitals is already well under way; an eminent authority has predicted that it will soon become universal. Already the hospitals are providing their corps of clinical chemists. Is it not time to make some special educational provision for the particular kind of combined training which will peculiarly fit men to discharge the functions of teaching, research and clinical control which have been indicated?

It may be suggested that adequate preparation for such work may be secured even now by pursuing the courses leading to the Ph.D. degree in chemistry and subsequently going on to the M.D. A few men do this and we recognize the *a priori* advantages which they possess over those who have only the one degree. But it is not economically sound to advocate this regimen for all who would so qualify themselves. Of the four years required for the medical degree (already it is five in those institutions which set the standards for to-morrow) more than half the time is devoted to the subjects of anatomy, surgery, obstetrics and minor allied subjects to which present or prospective chemical methods are only remotely related. It would appear both desirable and feasible to provide in our medical schools (or some of them) a special course for men already thoroughly trained in chemistry. Within two years could be compassed intensive courses in biology, physiology, advanced physiological chemistry, pathology, bacteriology and internal medicine with very brief attention to such portions of other branches as might appear desirable. With a bachelor's degree including as much chemistry as is now obtainable would it not be possible to arrange such a special course as suggested and, following this with a year of research, grant at the end of seven years the Ph.D., D.Sc., or a new degree of equal dignity?

A few years ago the Division of Organic Chemistry held a symposium upon methods of teaching that subject. If there are enough of the members of this Biochemical Division who are interested in the suggestions raised, or in allied considerations, it might be of advantage to provide at some future meeting for a similar free discussion of the whole matter. Out of such a frank canvassing of the situation there should come results which would enable the chemistry of the future to offer even more substantial contributions than the chemistry of the past has made to the science and art of medicine.

L. JUNIUS DESHA

MEMPHIS, TENN.

THE SCHOOL OF HYGIENE AND PUBLIC HEALTH AT THE JOHNS HOPKINS UNIVERSITY[1]

Our president, with a self-denial which I might appreciate, has intrusted to me the agreeable function of announcing upon this occasion one of the most important and gratifying gifts ever bestowed upon this university, a benefaction likewise of national interest. This is the provision of funds by the Rockefeller Foundation for the purpose of establishing in connection with the Johns Hopkins University a school of hygiene and public health. This action of the foundation was communicated to the trustees of the university only today shortly before these exercises. It is hardly necessary to add that the trustees have acted promptly in accepting this generous gift and have already taken the first steps toward organization of the new school in selecting Dr. Howell as the head of the physiological division of the institute of hygiene and to cooperate in the work of organization and development, and in appointing me as director.

It is expected that the school will be opened in October, 1917, as it is estimated that a year will be required for the planning, construction and equipment of the building and the gathering together of the staff of teachers. The necessary funds for construction, equipment, maintenance and expenses of the school will be provided by the Rockefeller Foundation.

When we consider the revolutionary discoveries of the last forty years in our knowledge of the causes and means of prevention of diseases, the great progress in the science and art of public health and the incalculable benefits to the community in the application of this knowledge, we can all realize the beneficent service rendered to this great cause by this latest gift of the Rockefeller Foundation, which has already contributed so largely to the advancement of medical science and education. Not only this university, but also this city and state and the whole country owe a great debt of gratitude to the foundation for the provision thus made of improved opportunities for training in preventive medicine and public health work and for cultivation of the sciences which find application in public and personal hygiene.

It is naturally most gratifying to us that Baltimore and the Johns Hopkins University have been selected for the location of the new school of hygiene and public health. Our city, in its situation, its relations to the south and other parts of the country, its proximity to the national capital, and its opportunities for study and work in the field of preventable diseases, is favorably located for such a school. I think that I may say that determining considerations have been the advantages arising from close association of the school with the medical school, the hospital, the school of engineering and other departments of the Johns Hopkins University, and it is for these reasons especially that the decision reached by the foundation after prolonged and careful study of the situation in different parts of the country is so gratifying to us. The wider extension of the influence and usefulness of the university, the possibilities of greater service to this city and state and to the country at large about to be opened by the new school, should materially strengthen the position of the Johns Hopkins University and aid in securing much-needed support in the development of other departments.

While the detailed plans of organization of the school of hygiene and public health will be worked out and announced later, a few points may here be touched upon.

Inasmuch as the profession of the sanitarian and worker in public health, although closely connected, is not identical with that of the practitioner of medicine, the school of hygiene and public health, while working in cooperation with the medical school, as well as with the school of engineering, will have an independent existence under the university coordinate with these schools. Opportunities in each will be available to students of the other schools.

The central and principal feature of the school will be an institute of hygiene housed in its own building, provided with the requisite

[1] Remarks by Dr. Wm. H. Welch at the commencement exercises of the Johns Hopkins University, as reported in the University Circular.

laboratories and facilities and with its own staff of teachers giving their entire time to the work of teaching and investigating.

There will be here laboratories of sanitary chemistry, of physiology as applied to hygiene —a most-important although much-neglected subject—of bacteriology and protozoology, and provision for epidemiology, industrial hygiene, vital statistics, a museum, library, etc. Additional facilities for instruction and research will be supplied by the medical and the engineering schools, the hospital, especially the newly opened wards for infectious diseases of the Harriet Lane Home for Invalid Children, and other departments of the university, which will be aided in undertaking the new work.

It is anticipated that mutually helpful relations will be established with our municipal and state departments of health, assurance of which has been given by our public-spirited mayor and other authorities, and with the federal public health service, whereby opportunities will be afforded for field work and other practical experience in various branches of public-health work.

Especially advantageous will be the relations with the International Health Commission of the Rockefeller Foundation, which is engaged in the study and control not only of hookworm, but also of malaria, yellow fever and other tropical diseases, which will receive due attention in the work of the institute.

It is intended that the school shall furnish opportunities of a high order for the cultivation of the various sciences which find application in hygiene, sanitation and preventive medicine, and for the training of medical students, engineers, chemists, biologists and others properly prepared who wish to be grounded in the principles of these subjects, and above all for the training of those who desire to fit themselves for careers in public-health work in its various branches—that most attractive profession for those qualified to practise it. The most urgent need at the present time is provision for the scientific training of prospective health officials and for supplementary and advanced courses for those already engaged in sanitary work. Suitable recognition of the satisfactory completion of work in the school will be given by the bestowal of certificates and degrees.

Directions in which it may be expected that the usefulness of the school of hygiene and public health will be extended are cooperative efforts with our training school for nurses and other agencies in the training of public-health nurses, who have become such important agents in voluntary and public-health work, and in the education of the public by exhibits, lectures and other means to a better application and understanding of the significance and needs of public and personal hygiene.

The dreams which many of us in the medical faculty have long cherished are now about to be realized. The opportunity which this great benefaction places in the hands of the Johns Hopkins University is most inspiring. It is comparable to that presented to the university at its beginning for the promotion of higher education, and later to the medical school and the hospital for advancement of the standards and methods of medical education. The responsibilities devolving upon the university in this new undertaking, entrusted to it with such high hopes, are commensurate with the splendid opportunities. May we not confidently anticipate that in this new field the results will be in keeping with the achievements of the university in the other fields it has cultivated so successfully?

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

RECENTLY the managers of the Second National Exposition of Chemical Industries, at the Grand Central Palace, New York, during the week of September 25, had to arrange the second floor for exhibits, and now they report that there are but a few spaces still remaining on that floor.

To meet the requirements of the societies which will hold meetings at the Grand Central Palace the auditorium has had to be increased in size, so that now it will comfortably seat 500 persons. An automatic motion-picture machine of the latest design will be used to display the motion pictures, many of which

will be loaned by exhibitors. In many cases there will be lectures to take the audience through a pictorial tour of a plant and they will be shown machinery and processes in the manufacture of materials that, until then, had never been previously shown. Many of the films are at present being made and are expected to be finished in time to be shown at the exposition. A few of these films are as follows:

Making of Black Powder,
Manufacture of Iron,
Manufacture of Fertilizers,
Mining and Manufacturing of Iron,
Manufacturing of Silk,
Making of Blotting Paper,
Silver Mining,
Manufacturing of Varnish,
Asphalt.

Two other features of the exposition that have been added this year are a large section showing the opportunities that await the chemist in our south and known as the "Southern Opportunity" section and a section for the "Paper and Pulp Industry" composed of materials and machinery used in the manufacture of paper and other related products.

The "Southern Opportunity" section is an ambitious undertaking to display the latent wealth in the undeveloped resources of the south. It will show that the materials have formerly been shipped to foreign countries to be enhanced in value by manufacture and returned to the original producers at a greater price.

The Bureau of Mines is preparing an elaborate exhibit that will cover much space—it will be a working exhibit, one where the visitor can see the "wheels go round."

The exposition will be opened by Dr. Charles H. Herty, president of the American Chemical Society and chairman of the exposition advisory committee. Mr. Francis A. J. Fitzgerald, president of the American Electrochemical Society, and Arthur B. Daniels, president of American Paper and Pulp Association, will also make addresses.

The American Chemical Society, whose annual meeting is being held during the week and in conjunction with the exposition, has arranged for conference meetings at the exposition. Other meetings of the society will be held at Columbia University, at the College of the City of New York and the Chemists Club.

The Chemists Club, which is a few squares from the Grand Central Palace, has been selected as the headquarters of the American Chemical Society, and on Monday afternoon the council of the society will hold a business meeting there, followed by a dinner tendered to the council by the New York Section.

The American Electrochemical Society has arranged a series of meetings beginning on Thursday morning, September 28, with the "Made in America" technical session at the Grand Central Palace. This session will be devoted to papers and discussions on the varied electrochemical industries of America, followed on Friday morning by another technical session, devoted to the theoretical side of electrochemistry. Registration will be on Wednesday evening at the exposition, headquarters of the society being at the Electrochemical Society booth.

The Technical Association of Pulp and Paper Industry, which is also holding meetings in conjunction with the exposition, is arranging headquarters in the midst of the "Paper and Pulp Industry" Section on the second floor of the Grand Central Palace. A large number of interesting papers are promised on the technical aspects of pulp and paper manufacturing. On Friday morning the meeting will be held in the auditorium at the Grand Central Palace, and the afternoon meeting will be a joint conference with the American Chemical Society.

The members of the American Chemical Society and the American Electrochemical Society will receive badges which will admit them to the exposition without further tickets.

SCIENTIFIC NOTES AND NEWS

Sir T. Clifford Allbutt has been elected president of the British Medical Association. A message of congratulation was at the time sent to him on the attainment of his eightieth birthday which occurred on July 20.

SIR NORMAN LOCKYER has been elected a foreign honorary member of the American Academy of Arts and Sciences.

THE Paris Academy of Sciences has voted to confer its Delalande-Guerineau prize on Sir Ernest Shackleton.

PROFESSOR C. F. MARVIN, chief of the Weather Bureau, and Dr. L. O. Howard, chief of the Bureau of Entomology, have been appointed by the secretary of agriculture to represent the U. S. Department of Agriculture on the Council of Research which is being organized by the National Academy of Sciences.

THE forty-fourth annual meeting of the American Public Health Association will be held in Cincinnati, October 24 to 27, under the presidency of Dr. John F. Anderson, of New Brunswick, N. J., formerly assistant surgeon general of the United States Public Health Service.

DR. EMERY R. HAYHURST, of Columbus, has resigned as chief of the bureau of occupational diseases of the Ohio State Department of Health, to accept the assistant professorship of industrial hygiene in the Ohio State University. Dr. Roscoe P. Albaugh succeeds Dr. Hayhurst as chief of the bureau of occupational diseases.

THE Chicago commissioner of health has appointed a committee to undertake research on infantile paralysis. The members are: Dr. M. Herzog, chairman, and Drs. K. Meyer, H. B. Thomas, A. Hoyne and A. K. Armstrong.

J. N. B. HEWITT, of the Bureau of American Ethnology, is continuing this summer his ethnologic researches among the Iroquois tribes.

VAN H. MANNING, director of the bureau of mines of the department of the interior, visited Seattle on August 14 for the purpose of determining whether the experimental mining and metallurgical station to be established in the northwest by the federal government should be in Seattle. Dean Milnor Roberts, of the college of mines of the University of Washington, has offered the facilities of his college for use by the station and has asked that the station be located on the university campus. Mr. Manning also inspected other possible locations for the station.

DR. W. A. MURRILL returned on August 21 from a vacation of two weeks spent in the Catskills, at Arkville, Delaware County, New York, where he obtained about 400 numbers of fungi for the New York Botanical Garden herbarium. Arkville is of special interest to botanists in New York City because it is included in the local flora range and furnishes many species found in the Adirondacks.

THE George Williams Hooper Foundation for Medical Research of the University of California has sent a member of its staff, Dr. Ernest Linwood Walker, associate professor of tropical medicine, to South America, to carry on investigations as to tropical diseases on the upper reaches of the Amazon. He will be stationed for most of the year 1,500 miles up the Amazon, in the region of Porto Zelho, Rio Madeira, Amazon, Brazil. For his researches as to parasitic infections of man he is to have the privileges of the hospital maintained there by the Madeira-Mamora Railroad, of which the medical director is Dr. Allen M. Walker, a graduate of 1907 of the University of California Medical School.

A CABLEGRAM to the press from Buenos Aires reports that Sir Ernest Shackleton left Punta Arenas, Chile, on August 26, on board the ship *Yelcho,* to make a third attempt to rescue the members of his expedition marooned on Elephant Island.

AT the meeting of the American Chemical Society, to be held in New York, from September 25 to 30, the program will include a symposium on occupational diseases which will be presided over by Professor Charles Baskerville, head of the department of chemistry of the College of the City of New York. Among the topics which will be discussed are the chemical trades, prophylaxis in chemical industry, diseases incidental to work in aniline and other coal tar products, cedar lumber, mines and explosives. There will be a general discussion, the speakers including Dr. W. Gilman Thompson, of New York; Dr. F. L. Hofman, Dr. J. W. Schereschewsky, G. P.

Adamson, H. K. Benson, W. A. Lynott, Alice Hamilton and J. B. Andrews.

Dr. Charles Lincoln Edwards, director of nature study in the Los Angeles Public Schools, gave an illustrated lecture on the evening of August 16 before the California Academy of Sciences on his experiences in the Bahama Islands.

The eighth biennial vacation course in connection with the School of Geography at Oxford was held this year between the 3d and 18th of August. The opening address was given by Dr. Keltie on "The Progress of Geography in the last half-century and its present position."

At the annual meeting of the British Pharmaceutical Conference, held on July 12, Dr. David Hooper devoted his presidential address chiefly to an account of the drug resources of India and the British colonies.

Arthur Marion Brumback, professor of chemistry in Denison University since 1905, died on August 12, aged forty-seven years.

William Scrugham Lyon, known as an authority in botany and horticulture in the Philippine Islands, died on July 20, in Manila. Mr. Lyon served at one time as head of the California State Board of Forestry. In 1902 he went to the Philippines for the Bureau of Agriculture. In 1905, he left this bureau to engage in the business of collecting and exporting orchids, in which he continued until the time of his death.

Professor Scott, of the electrical engineering department of Robert College, Constantinople, has been killed by contact with a wire carrying 10,000 volts.

Dr. J. A. Harvie-Brown, a Scottish landed proprietor and ornithologist, died on July 26, at the age of seventy-two years.

Among deaths in the war announced in *Nature* are: C. M. Selby, formerly assistant naturalist in the Dublin National Museum; A. St. Hill Gibbons, known for his geographical explorations in Africa; Arthur Poynting, only son of the late J. H. Poynting, F.R.S., an engineer; and George Andrew Herdman, only son of W. A. Herdman, F.R.S., who, though only twenty years of age, had published investigations on biological problems.

The death is announced of Dr. Alexandre Layet, formerly professor of hygiene at Bordeaux, and correspondent of the Paris Academy of Medicine.

According to the report presented to the British Medical Association, more than 400 British physicians have lost their lives at the front in the past twelve months.

Twenty graduates of American universities left Paris for the front on August 16, as members of a newly formed section of the American ambulance field service.

The sum of $50,000 has been given by Mrs. Streatfeild, to be held in trust jointly by the Royal College of Physicians of London and the Royal College of Surgeons of England, for the promotion of research.

It is announced that the present Lord Avebury has handed to the British Museum authorities, for retention in the national collection or distribution among provincial museums, certain portions of the late Lord Avebury's collection of prehistoric and ethnographical specimens from various parts of the world, use of which was made in the writing of "Prehistoric Times." The gift includes a fine series from the early Iron Age cemetery at Hallstatt, Upper Austria, which will be kept in the British Museum, but many of the stone implements are available for distribution.

Regulations for enforcement of the new federal migratory bird law have been approved by President Wilson and now are effective. Shooting is prohibited between sunset and sunrise. Insectivorous birds are protected indefinitely, and no open season is allowed. Band-tailed pigeons, cranes, wood ducks, swans, curlew, willet, upland plover and smaller shore birds are protected everywhere until September 1, 1918.

In his address at the anniversary meeting of the Royal Geographical Society, Mr. Douglas Freshfield gave some details in regard to the map of Europe and the Nearer East on the 1:1,000,000 scale. Twenty-two sheets of the map have been compiled by the society

and reproduced and published by the geographical section of the general staff; eighteen sheets have been compiled and are in process of reproduction, while seventeen others are in a more or less advanced state of preparation. The scope of the map has been extended northward to the North Cape and the new Russian port of Alexandrovsk, eastward to Baghdad and the Caspian, and southward to Cairo and the head of the Persian Gulf.

THE fifth Brazilian Geographical Congress will, as we learn from *Nature,* be held at Bahia on September 7–16. There will be twelve sections, devoted respectively to the following subjects: Mathematical Geography (astronomical geography, topography, geodesy); Physical Geography (aerology, oceanography, geomorphology); Physical Geography (hydrography, potamology, limnology); Vulcanology and Seismology; Climatology and Medical Geography; Biogeography (phytogeography and zoogeography); Human Geography; Political and Social Geography; Economic and Commercial Geography, including Agricultural Geography; Military and Historical Geography; Teaching of Geography, Rules and Nomenclature; Regional Monographs.

AMONG the forthcoming publications announced by the University of Chicago Press are the following:

The Control of Hunger in Health and Disease, by Anton J. Carlson.

Finite Collineation Groups (The University of Chicago Science Series), by Hans F. Blichfeldt.

Parallaxes of 27 Stars, by Frederick Slocum and Alfred Mitchell.

Second-year Mathematics for Secondary Schools, by Ernst R. Breslich.

Agricultural Economics, by Edwin G. Nourse.

The Psychology of Religion, by George A. Coe.

Truancy and Non-attendance in Chicago, by Sophinisba P. Breckinridge and Edith Abbott.

The Electron (The University of Chicago Science Series), by Robert Andrews Millikan.

Quarter-centennial Bibliography of Faculties, by a Committee of the Faculty of the University of Chicago.

THAT 1915 was the most successful year of production in the history of the petroleum industry is shown by statistics just compiled under the supervision of J. D. Northrop, of the U. S. Geological Survey, Department of the Interior. The total quantity of crude petroleum entering the world's markets in 1915, which amounted to 426,892,673 barrels, exceeds the former record, established in 1914, by 28,194,307 barrels, or 7 per cent. The bulk of the increase in 1915 came from the United States and Mexico, though Russia, Argentina and Japan recorded significant gains. The distribution of this production is shown in the following table:

Country	Barrels of 42 Gallons	Per Cent. of Total
United States	281,104,104	65.85
Russia	68,548,062	16.06
Mexico	32,910,508	7.71
Dutch East Indies	12,386,808	2.90
Roumania	12,029,913	2.82
India	7,400,000	1.73
Galicia	4,158,899	.98
Japan and Formosa	3,118,464	.73
Peru	2,487,251	.58
Germany	995,764	.23
Trinidad	750,000	.18
Argentina	516,120	.12
Egypt	221,768	.05
Canada	215,464	.05
Italy	39,548	.01
Other	10,000	
	426,892,673	100.00

THE twenty-seventh annual conference of the Museums Association was held in Ipswich on July 10–12, when, as we learn from *Nature,* the following institutions were represented by delegates: (1) Five national museums—the British Museum, the British Museum (Natural History), the Victoria and Albert Museum, the National Museum of Wales, and the Museums of the Royal Botanic Gardens at Kew; (2) two London museums—the Horniman Museum and the Wellcome Historical Medical Museum; (3) the following twenty-five provincial museums and art galleries—Brighton, Bristol, Carlisle, Chelmsford, Derby, Dundee, Exeter, Halifax, Hastings, Hull, Ipswich, Leicester, Lincoln, Liverpool, Merthyr Tydfil, Newbury, Norwich, Perth, Peterborough, Plymouth, Reading, Salford, Warrington, Worcester and Worthing; and (4) the Museum of the University of Manchester. After a welcome by the mayor of Ipswich, the president, Mr. E. Rimbault

Dibdin, curator of the Walker Art Gallery, Liverpool, addressed the delegates, taking as his subject the effect of the war upon the art museums of the country. He had sent a series of questions to eighty-two art museums in Great Britain, and from their answers was able to give some interesting details as to their experiences. Briefly summarized, his remarks indicated that whereas several London galleries have been closed by the action of the government, and one or two others report a reduced attendance, the majority of the provincial institutions show an increased attendance, and only one has been closed. It thus appears that the protest lodged with the prime minister by the Museums Association against the government retrenchment committee's suggestion that provincial museums and art galleries should be closed has been thoroughly justified.

At the coming convention of the American Electrochemical Society which will be held in New York from September 27 to 30, one of the sessions will be devoted to "Made in America" products of the electric furnace and electric cell. These products include many of our most important staples such as copper, aluminum, abrasives, bleach and many more. It is an interesting fact that whereas other chemical industries, such as the coal-tar dye industry are primarily European, the electrochemical industry is largely American. It is here that the production of aluminum was invented and put on a commercial basis. The first plant for the electrical synthesis of the elements of the air and the production of artificial fertilizer nitrate was erected at Niagara Falls. At the Falls, also, tons of abrasives are produced in large powerful electric furnaces. The importance of these abrasives can best be appreciated by the fact that if these supplies were to cease to-day practically every mill and factory in the country would have to shut down within three months' time. Other electrochemical products of decided economical importance and value are graphite, phosphorus, hypochlorite of lime, magnesium, metal, carbon bisulphide, calcium carbide, hydrate of sodium, ferro silicon and other iron alloys which are indispensable to the steel trade.

We learn from the London *Times* that the British Advisory Council for Scientific and Industrial Research announces that it is appointing standing committees of experts to report on proposed researches of great importance submitted to it. Committees in mining and metallurgy have already been formed, consisting both of scientific men and of leaders of the industries concerned. Each committee will have two sections. Sir William Garforth, the coal owner, is chairman of the mining committee and of its nonmetals section, and Mr. Edgar Taylor, of the firm of John Taylor and Sons, owners of mines in various parts of the world, will preside over its metals section. Sir Gerard Muntz, of the Muntz Metal Company (Limited), Birmingham, has accepted the chairmanship of the metallurgy committee and of its non-ferrous section, and Sir Robert Hadfield, F.R.S., of Hadfield's (Limited), Sheffield, is chairman of its ferrous section. A similar committee for engineering is contemplated. The council is making grants to various societies to enable them to continue researches already in progress for which the necessary staff and equipment are obtainable, and quite recently valuable results have been obtained from researches connected with the production of optical glass. The council has also recommended a grant in aid of an important new research into the manufacture of hard porcelain, especially for domestic purposes. This has been undertaken by the Stoke-on-Trent Central School of Science and Technology, and the Staffordshire Potteries Manufacturers' Association, with a view to establishing the manufacture of hard porcelain in this country. Particulars have been obtained of the research work, not only of the scientific and professional societies, but also of the universities and higher technical schools, with a view to establishing a register of research. The possibility of collecting information under the seal of confidence as to the research work of particular firms is also being considered. The training of an adequate supply of research workers will be an important branch of the advisory council's work. It is impossible to announce definite

plans during the war, but the council has already made recommendations which, if adopted, will, it believes, secure that all that is practicable in existing circumstances shall be done.

UNIVERSITY AND EDUCATIONAL NEWS

AN endowment of $70,000, to create the "Howison Foundation," has been given to the University of California by George Holmes Howison, professor of philosophy, emeritus, in the University of California, and Lois Caswell Howison, his wife. Subject to an annuity during their lifetime, the endowment is to maintain the Howison Traveling Fellowship, of $1,200 to $1,500 a year, $600 a year to constitute the Lois Caswell Fund for the Dean of Women to aid deserving women students, and three or four Anne Sampson scholarships or fellowships, in honor of Mrs. Howison's mother, for women students in English literature and criticism.

DR. ALICE ROHDE has been appointed instructor in research medicine in the George Williams Hooper Foundation for Medical Research of the University of California. A graduate of the University of Chicago of 1903 and of Johns Hopkins Medical School of 1910, Dr. Rohde has had special training in research medicine under Professor Walter Jones and Professor J. J. Abel at the Johns Hopkins University and under Dr. Emil Fischer at Berlin.

DR. JOSEPH H. GROSSMAN, of Cleveland, has been appointed lecturer on diagnosis of tuberculosis in the school for applied social sciences of Western Reserve University.

AT the last meeting of the corporation of the Massachusetts Institute of Technology the following assistant professors were promoted to be associate professors: Daniel F. Comstock, theoretical physics; George L. Hosmer, topographical surveying; C. L. E. Moore, mathematics; Ellwood B. Spear, inorganic chemistry; William E. Wickenden, electrical engineering. The following instructors were made assistant professors: James M. Barker, structural engineering; Ralph G. Hudson and Waldo V. Lyon, electrical engineering, Earl B. Millard, theoretical chemistry; Thomas H. Huff, aeronautical engineering.

MR. T. E. GORDON has been appointed professor of surgery in Trinity College, Dublin, in succession to Professor E. H. Taylor.

PROFESSOR J. J. VAN LOGHEM has been appointed to the newly founded chair of tropical hygiene in the University of Amsterdam.

DISCUSSION AND CORRESPONDENCE

AMBLYSTOMA NOT AMBYSTOMA

TO THE EDITOR OF SCIENCE: In a letter printed in SCIENCE for June 30, 1916 (43: 929), Dr. M. W. Lyon, Jr., presents and defends the thesis, "*Ambystoma* not *Amblystoma*." If so, the spotted salamander has another spot on his name. *Ambystoma* is a dark saying. Dr. Lyon refers to the original paper of the author, Tschudi, 1839 (Scudder gives 1838), and says that the name is "written by him *Ambystoma* in four different places in his work, and only in that manner." He adds: "The derivation of the word is not given by him, and there is nothing to indicate that he intended *Amblystoma* and made a lapsus calami."

But outside of Tschudi's print, there *is* something to indicate that he intended *Amblystoma,* and made a lapsus of some sort; namely, the fact that *Ambystoma* has no assignable meaning in any known language, while *Amblystoma* has an assignable meaning in the language of science—that European or cosmopolitan Latin which has supplied the main vocabulary of science, and will probably supply it for ages to come; being, like the rustic's indefluent river, *in omne volubilis aevum.*

In this voluble vocabulary *Amblystoma,* or the adjective latent behind this name, means "having a blunt mouth." In form and meaning it is parallel to *Amblystomus,* the name of a genus of beetles, and to *Amblyrhynchus,* the name of a genus of lizards—which are cousins, once removed, of salamanders. These are but three of a long string of zoologic names beginning with *Ambly-*. But *Ambystoma* stands alone, though it appeared in the same decade with most of the others.

Whether *Amblystoma,* with the sense "having a blunt mouth," is an accurate or a suita-

ble name for the hapless salamanders to which it, or *Ambystoma,* has been applied, is a separate question.

If the framer of the word which first appeared as *Ambystoma* did not state the intended formation or the intended meaning, and if his description does not give a clue, it was a case in which science, for once, made a mistake—it left uncertain what it might have made certain.

One must guess, or reason out, what the author meant. His hand wrote—what? His printer printed *Ambystoma.* He printed it four times, we are told; but the second, third and fourth times may merely prove the meticulous care of the printer to repeat the first error, and thereby to secure that pleasing uniformity of error which is the undying passion of that deserving tribe. (What the tribe deserves I will not here disclose.)

Now, any scientific gentleman who thinks that it is a proper plan to form, print or defend a word *Ambystoma,* as a name for even the humblest of God's creatures, ought to consider whether he can "get across" with it. He may, indeed, find champions among his learned associates, especially among those to whom a printed error in a scientific work, if made early in the morning (I allude, of course, to one aspect of the rule of priority), has a Mohammedan or Shakespearian sacrosanctity; and some of these champions may try to support the error by daring flights into the clouds of etymology; as, in this case, the attempt mentioned by your correspondent, to support *Ambystoma* by capturing as its source a Greek phrase that is erroneous in itself, is nonexistent (except in the clouds), and could not without violence be persuaded to assist in forming such a word.

The fact that this imagined Greek phrase is in Science printed with one error in each of its three words, exonerates the printer from the censure of Mohammedan superstition. If I were to repeat the phrase here, he would be quite willing, I am sure, to oblige us with other variations. The printer of Tschudi was more rigid: "What I say *four* times is true."

But supposing that *Ambystoma* does not mean anything, what of it? Are we not often told that a name in zoology need not mean anything—that it may be a mere label, like a number?

This answer, however, does not meet the point. Names that *seem* to be formed from the Latin or Greek vocabulary in the usual manner will for ever be compared with their apparent sources; and anomalous names like *Ambystoma* or *Liopa* or *Fedoa* will for ever be challenged by scholars; and no agreement by a committee to take the first form found in print, or to acquiesce in de-facto fictions, will settle the question or the questioning. *Ambystoma,* so printed, *seems* to be intended for a word of the usual Latin and Greek vocabulary; but it means nothing, and it looks as if it were an error for *Amblystoma;* and to that form Agassiz corrected it.

I will not dwell upon the fact that *Amblystoma,* though a deliberately corrected form, is itself, considered as a neuter noun requiring a neuter specific adjective (*Amblystoma maculatum*), etymologically incorrect. But this point has been ignored in the framing of many New Latin names: and to consider it here were perhaps to consider it too curiously. Nevertheless, a fact ignored is still a fact *there.*

Ambystoma, then, it seems, has no right except the right of having started wrong. But the right of having started wrong is a right which the world is much disposed to admit. This is the case with many respectable sects and parties that have continued long upon the wrong road, and now obey at eve the erring voice which they obeyed at prime; or hold extra conventions to ascertain their principles. Whatever *was,* is right. Personally and scientifically, I do not believe this; but it is evident that many persons find a satisfaction in dogmas of literature and zoology, and in names and forms of words, that arose in former times. The glamour is in the preterition. These things *were.* That is something. The past, at least, is secure. Such things have a history; and they are at any rate free from the vice of being up to date.

It should be noted that the difference between *Ambystoma* and *Amblystoma* is not,

really, a difference of "spelling." *Scimitar, simitar, simiter, cimiter,* are four out of more than thirty spellings of one word, and *amoeba* and *ameba* are two spellings of one word; but *Ambystoma* and *Amblystoma,* whatever their status may be in zoology, are either two different words, or else two forms, one erroneous, of one word. No one asserts that they are two different words. All who have spoken agree that one is an erroneous form of the other. Which was intended? Let it be decided.

In all scientific compound names, intention is supposed to be present; and for this reason it will always be necessary that "science" shall correct what "science" has erroneously published; in other words, that Jones and Robinson shall correct the errors of their distinguished predecessors Brown and Smith. This is good science, and good fun, too, for Jones and Robinson. What but this, indeed, is the progress of science?

Is there not a scientific error in the attitude of those scientific men who prefer to take the first form and "have done with it"? Can science have done with anything? What the advocates of priority do is, in fact, to turn over an unfinished job to other men. This is reasonable enough, if they will let the other men finish it.

It were to be wished that the advocates of rule in zoologic nomenclature would play one game or the other—either the good old Presbyterian euchre, in which words are borrowed or manufactured orthodoxly from Greek and Latin sources (admitting, also, some heathen of the better sort), or else the less exacting Mohammedan solitaire, whose first law is the chance priority of print. It is hardly fair to mix with cards bearing the good old Presbyterian names of *Amblycephalus, Amblychila, Amblycorypha, Amblyopsis, Amblyrhynchus,* and the rest, a card bearing the Mohammedan and solitaire appellation of *Ambystoma.* (I am assuming that euchre and solitaire are played with cards.)

If this isolated *Ambystoma* is correctly formed, tell us how it is done and what it means. And then throw it out, nevertheless; for the scientific reason that it would be forever confusable with the similar-seeming words with which, on the Mohammedan theory, it has no connection.

Notwithstanding all the politic reports and mosaic codes of the committees on nomenclature, committees which have done an inestimable service to science, and which should be liberally supported by money and advice (two sources of enrichment, of which one will never fail), I hold that it is the duty of scientific men to correct the errors which they find within their own domain; or at least not to enforce or prolong any error, great or small, by devotion to any rule of priority or any other hand-made rule intended to serve convenience in registration, regulation, indexing or proofreading. It is not right to make a rule out of chance and to call it a rule of order. It is not right to set up priority, which is a part of history, and to call it science, which is a part of reason.

If we will use the language of science, we must apply the science of language. And we must not ignore or reject that science on the ground that "the authorities differ" or that "the doctors disagree." Let me end with a hard saying: The doctors do not disagree. It is only some writers and advisers and committee men who disagree. The rest of us are agreeably unanimous. Let every man of science place his hand upon his heart, and agree!

CHARLES P. G. SCOTT

YONKERS,
July 28, 1916

AMBYSTOMA

IN connection with Professor M. W. Lyon, Jr.'s note on "*Ambystoma* not *Amblystoma*," I may mention the fact that Dr. Willard G. Van Name used *Ambystoma* as the scientific generic name of the spotted salamander in Webster's "New International Dictionary" which was published in 1909.

F. STURGES ALLEN

THE LIME REQUIREMENT OF SOILS

TO THE EDITOR OF SCIENCE: At this time when methods for the determination of the lime requirement of soils are receiving much

attention it is desired to point out several improvements in the lime-water method, as described in *Journal of the American Chemical Society, 26,* p. 661.

It has been found that to "draw off" the supernatant liquid and boil it to a volume of about 5 c.c. may lead to errors of 200 or 300 parts per million, because traces of soluble alkaline lime salts may not diffuse into the upper portion of the supernatant liquid. The method has been modified to read

> . . . allow to stand over night, with occasional shaking, shake thoroughly and filter immediately through a neutral filter paper (S. & S. 588 is good) rejecting the first 10 to 15 c.c., or until the filtrate is quite or nearly clear, place in a Jena (Nonsol or Pyrex, or other insoluble glass may be used) beaker. . . .

I have realized from the first that the lime-water method gives high results on soils very rich in organic matter. One of the reasons for this was recently observed by Mr. Holman, of this laboratory. It is that the characteristic pink color developed when phenolphthalein is added to an alkaline solution is often almost immediately destroyed rather than masked in solutions containing much dissolved organic matter.

The error which may be thus introduced is lessened but not entirely eliminated by boiling down the filtrate to about 10 c.c. and adding, watching carefully meanwhile for the temporary pink color, the phenolphthalein a drop at a time.

This is not the only cause for the high results obtained on soils rich in organic matter. Other causes, modifications to eliminate them and improvements simplifying and shortening the method, will be presented at an early date.

F. P. Veitch

Washington, D. C.

THE SURVIVAL OF BEAT IN THE REMOVED HEART OF THE SNAPPING TURTLE

The aim of the present note is to place on record the details of the survival of pulsations in the heart of the snapping turtle. A specimen having a shell-length of about twelve inches was captured in the vicinity of Kingston by one of the boys of the community. For three days it was kept in a tub without food and on the fourth was killed and dressed "to make a stew." The writer was not present at the killing which occurred at 9:45 in the morning. The heart was brought to the laboratory at 10:45, the boy being interested in the fact that the beating continued. At the time the writer first observed the specimen it was lying in a small pool of blood in a saucer with the vessels cut short. It was then beating strongly at the rate of eleven times per minute. At 11:35 the blood was washed out of the saucer and normal salt solution added to partly cover the organ. The further record of the beats per minute was made as follows, the room temperature being 73° F.

9:45	turtle killed.
10:45	rate 11 beats.
11:05	rate 12 beats.
11:35	rate 12 beats.
12:30	rate 16 beats.
1:00	rate 18 beats.
1:30	rate 18 beats.
2:00	rate 18 beats.
2:30	rate 18 beats.
3:00	no contractions.

From the above it will be observed that the contractions continued at a slightly increasing rate for a period of about six hours. At the end of this time mechanical stimulus failed to produce further contractions.

Philip B. Hadley

Kingston, R. I.,
June 27, 1916

QUOTATIONS

SCIENTIFIC SOCIETIES AND THE GOVERNMENT

The letter in the *Times* of Professor E. G. Conklin, of Princeton, pointing out that no president has given such generous recognition to the National Academy of Sciences and other scientific bodies as Wilson, deserves larger attention than it will get. It occurs to few that the government could make profitable use of scientific auxiliaries. Though the National Academy of Sciences was authorized fifty-three years ago by Congress, in response to a demand by Alexander Bache, superintendent of the Coast Survey, for an official organization for research; though it was launched with a membership including Agassiz, Davis,

Gray, Dana, Guyot, Peirce, Joseph Henry and Hilgard; and though it has numbered the best American scientists since, it has made little popular impression. Professor Conklin states that Wilson was the first president to ask its advice in appointing an expert—following its recommendation in choosing the chief of the Weather Bureau. Again, though the American Society of Naturalists and the American Society of Zoologists had appealed in vain to McKinley to appoint a trained man commissioner of fisheries, Wilson not only promised to do so, but named the man they recommended. He has also followed expert advice in choosing the chief chemist of the Agricultural Department and the chief of the Bureau of Mines; and has entrusted to the National Academy the important work of establishing a national research council.

The fact that the National Academy of Sciences has lagged behind the similar academies of Europe is traceable to various causes. One lies in the huge extent of our country, making difficult the frequent assembling of scientists at Washington, as they easily gather at London, Paris and Berlin. Our scientists are usually connected with universities scattered over the whole land, while in Europe the most important seats of learning are often situated at the capitals. But a main cause is clearly the lack of government support. The academy has had to rely for its work on money given by Bache, Agassiz, C. B. Comstock, Wolcott Gibbs, Apthorp Gould, Sir John Murray, and others, totalling only about $200,000—part of this to be devoted to prizes. It has had no home, and its building fund would disgrace any vigorous college fraternity. It has not received the number of commissions for the government—to be executed with government funds—that it might very well have had; and in some years has been almost inactive. It was once given such tasks as to suggest a means for restoring the Declaration of Independence, to canvass the various materials for cent coins, to show how to prevent counterfeiting, to offer a tariff classification of wools, to study glucose manufacture: tasks that would now be handed over to the government's own scientific bureaus. Only recently has it seemed that it may soon assume its proper place as a chief federal agency in many lines of research.

The Royal Society of Britain and the French Academy of Sciences are great institutions that this country can not at present equal. For two centuries they have been the centers of progress in research. The first had its period of weak governmental support, when it was too poor to publish Newton's "Principia," but it now has $20,000 a year and special grants, its own quarters, and the building formerly known as its workshop, now as the Royal Institution. Here have worked Faraday, Davy, Young, Tyndall, Dewar, Sir Joseph Thomson and others, many as brilliant in the lecture room as in research. It has supplied money and instruments to scientific expeditions all over the world, has assisted the self-governing dominions and India, and has performed such special tasks as that allotted the Sleeping Sickness Commission. The French Institute, set firmly on its feet by Colbert and Napoleon—the latter was a member—has had names as great, and at one period surpassed the best days of the Royal Society, with Laplace, La Grange, Becquerel, Fourier, Regnault, Gay-Lussac, Berthollet, Cuvier, Lamarck and Saint-Hilaire on its rolls. Our National Academy would do well if some day it rivalled that of Berlin, with its large new building, ample funds and tradition of consistently maintained research into Greek and Latin inscriptions, the Prussian law, and the history of the fixed stars; or if it became as important to America as the Stockholm Academy, which distributes the Nobel prizes, is to Sweden, or that at Petrograd to Russia. It must be given more of such work as it has had in reporting on a national board of health, on a plan for treating the national forests, on the survey of the territories, or on Philippine exploration. And it must somehow find funds to enable it to carry on extended researches in one field for years, and to undertake publishing, as do the European bodies.

If the National Academy were often consulted by the president about scientific appointments, we should only be following a

precedent long established in France. Whenever a professorship falls vacant there in one of the national universities, or the directorship of an observatory, or a similar post, the Academy of Sciences is asked to recommend a first and second choice to the proper officer —as the minister of public instruction. Our executives will never surrender a wide latitude of choice, but President Wilson has set a good example. So, too, his action in asking the academy to study the slides at Panama, and to form a body which should bring all the research agencies of the country into a position to cooperate with each other and the government in time of need, indicates a praiseworthy intention to heighten the prestige of the academy.—New York *Evening Post.*

SCIENTIFIC BOOKS

Meteorites, Their Structure, Composition and Terrestrial Relations. By Oliver Cummings Farrington, Ph.D., Curator of Geology, Field Museum, Chicago. Published by the author.

The mystery attendant upon the fall of a stone-like or metallic body upon our earth from the "realms of space" early attracted the attention of students of natural phenomena and aroused the curiosity and perhaps superstition of the uneducated. Singularly enough, however, the literature upon so fascinating a subject has, so far as the English-reading layman is concerned, for a long time been very unsatisfactory, consisting mainly of brief papers descriptive of individual occurrences, or catalogues of collections. The well-known books of Kirkwood and Lockyer treat the subject mainly from an astronomical standpoint. Fletcher's "Introduction to the Study of Meteorites," a British Museum publication, has been by far the most satisfactory treatise, but is scarcely known outside of the libraries of the specialist. In other languages we have Meunier's handbooks and treatises based on the collections of the Paris Museum, Brezina's on those of Vienna, and lastly Cohen's comprehensive "Meteoritenkunde," a work altogether too detailed and technical for the general reader. The book of Dr. Farrington, here under review, comes, therefore, opportunely into a field where there is plenty of room. In an octavo volume of 225 pages is given as fully as space will permit, a summation of present knowledge regarding *Meteorites, their structure, composition and terrestrial relations.* The leading chapters deal with the phenomena and time of falls, the size and form of individual meteorites, their structural features, chemical and mineralogical composition, origin and classification, with a final chapter on the principal public collections. From this last it appears that the collections of the British Museum, those of Vienna and Paris abroad, and of the Field Museum in Chicago, comprise each representatives of some 600 out of the known 634 falls and finds, the rapid growth of the last named collection being due to the acquisition of the Ward-Coonley collection in 1912. The national collections at Washington, numbered, as shown by a recent "Handbook and Descriptive Catalogue," 412 falls and finds (since increased to some 432), including the recently acquired "Shepard Collection." This wide distribution of the material from individual falls is worthy of more than passing notice. Prior to the eighteenth century, it seems such objects were rarely preserved in museums, or if so preserved, were hidden away, the custodians fearing to make themselves ridiculous by even acquiescing in their supposed ultra-terrestrial origin, and it was not until the publication of the works of Chladni in 1794 and 1819 that their accumulation for study began upon a truly scientific basis.

The earliest known undoubted meteorites still preserved are those of Elbogen, Bohemia, and Ensisheim, Upper Alsace, Germany, dating back to 1400 and 1492. These have been broken up and scattered throughout public and private museums the world over, Wulfing's catalogue showing that fragments of the Ensisheim stone are to be found in 66 different collections. It is sometimes questionable if the almost fanatic desire on the part of private collectors to secure fragments, however small, has not retarded rather than helped the cause, since it has not merely re-

sulted in hopelessly scattering the material, but has enabled dealers to enforce prices in many cases absurdly high and actually prohibitive so far as acquisition of material for analysis and study is concerned. The writer can speak feelingly on this point. To illustrate: A recent catalogue of a Philadelphia dealer advertises a perfectly commonplace type of meteoric stone at $5.00 a gram, the only possible excuse being that there was not much of it, and in falling it passed through the roof of a barn! Even higher prices have been recorded as paid by those whose chief aim appears to have been numbers and a new fall to add to their lists. The largest single individual meteorites in any collection in the world are those of Cape York, Greenland, and Willamette, Oregon, in the American Museum of New York.

From a consideration of the dates of all known falls it appears that such are most frequent in the months of May and June, the periodic star showers of August and November notwithstanding. Further it appears that of the 273 falls concerning which satisfactory datum is found, 184 occurred between the hours of noon and midnight, and 89 from midnight to noon.

Some interesting facts are brought out in the chapter on distribution, it being shown, apparently, that falls are most numerous in mountainous regions, as those of the southern Appalachians in our own country, or the Alps and Himalayas in Europe and Asia. The suggestion that this may be due to superior gravimetric attraction can not, however, for a moment be accepted; moreover, the reviewer can but feel that something is wrong in the premises, since but two falls can be credited to Switzerland, with its Alps, while the flat plains of Kansas have thus far yielded seventeen. It is of further interest to note that of the total of 634 known meteorites, 256 have been found in Europe and 117 in the United States, or more than two thirds the whole number from less than one eighth of the land surface; and still further, that of the 328 from the eastern hemisphere, 299 are stone and but 79 iron, while of the 256 from the western hemisphere, but 74 are stone and 182 iron. Whether these seeming anomalies have any meaning or are due merely to accident of find, the future must decide.

In the discussion of the origin of meteorites the author gives adherence to the theory that they are portions of a shattered planet or planetoid, and is apparently favorably inclined to the views of Chamberlin—to a probable source of disruption by differential attraction produced by the passage of a small body within Roche's limit of a larger one. In the chapter on terrestrial relations, comparison in chemical composition is made between the average composition of four meteorites, the acidity of which is above normal, and the average composition of terrestrial rocks. The reasons for the selection of but these four meteorites are not quite acceptable to the reviewer, but, incidentally it may be remarked that, in consideration of the question of the origin of the earth through an accumulation of meteoric matter, one is not necessarily led to the consideration of one so fluid as to become homogeneous throughout; indeed, Chamberlin recognizes the possibility of a relatively cold earth. In this case certainly the portions now available for study should conform within reasonable limits to that of the ingathered matter. That they do not conform to that now being ingathered, the reviewer has shown elsewhere. Is it not better to account for this on the very reasonable supposition that the materials now being ingathered do not represent in composition those which fell during the later periods of earth history, rather than ignore the extremely basic character of most meteorites and use for comparison only the four acidic types selected?

The book, to cut the review short, shows a thorough knowledge of the results achieved by other workers, and forms a very welcome addition to existing literature. It is well illustrated by half-tone figures of form and structure, those of microstructure being reproductions from Tschermak's well-known "Mikroskopische Beschaffenheit der Meteoriten."

GEO. P. MERRILL

U. S. NATIONAL MUSEUM

Theory of Errors and Least Squares. A Text-book for College Students and Research Workers. By LeRoy D. Weld, M.S. New York, The Macmillan Company, 1916. 8vo. Pp. xii + 190.

The two pages of "Preface" of this book made a very unfavorable impression on the reviewer. It would take too much space to point out the expressions that seemed catchy but meaningless or non-committal. It gave the impression that possibly the author had not caught the fundamental purpose and nature of the method of computation discussed in the volume. The idea of having the theory for its amateurish "satisfaction" and of getting it "in an evening or so and then put it into immediate practise" did not at all harmonize with the reviewer's knowledge that only a fairly experienced observer has much real use for the method of least squares in his computations.

As a text-book for "undergraduates," unless they are classed with the "casual readers," it presupposes a half-year at least of training in the calculus. Compare pages 54, 57, 60, 67, 71, 90 and others. Any student of the desirable amount of inquisitiveness would like to know under what conditions and to what extent he may play such tricks of the calculus as he sees, *e. g.*, following equation (*h*) on page 181; and it would take considerable advanced calculus to make it all clear to him.

As a book for "handy reference" it would be vastly more useful by having a carefully prepared, detailed index. This need is partially met by "Appendix F. Collection of Important Definitions, Theorems, Rules and Formulas for Convenient Reference," pp. 185 sq. Throughout, references are made to Article, Equation (number), or even to Chapter, without adding the page, which would facilitate the use of the book, since only page numbers appear on the tops of the pages. It would help much to have the number of the page on which each formula originally appears given as well as the number of the formula on pp. 188–190, and elsewhere.

Happily, the "Preface" is the poorest part of the whole book and that may be omitted by the reader. On pages 17 and 28 the author states clearly the "special office of the method of least squares," yet he nowhere emphasizes the fact that he is dealing with a method of *computation*. He does not make use of the splendid opportunity of forcing and fixing upon the attention of the reader the facts that the method does not improve the quality of poor or careless observations, and that only the beginning student carries readings as of grams out to six or seven decimal places (see any reference to grams, *e. g.*, p. 155). It further would not be difficult and much worth while to point out that in the formula $y = ce^{-h^2x^2}$ (24), p. 56, the exponent must be an abstract number so that $1/h$ and x must be measures in the same unit. The types of readers for whom the book is intended are the very ones that should have these matters indelibly impressed upon them. Although it is sometimes stated that illustrations are from students' work, it is passing strange that the author should have let such matters escape his notice.

Barring two cases of questionable English, pp. 65, 170, that only a purist might notice, the book is quite free of errors of speech and of typography. The treatment is remarkably clear and well-ordered. The topics are nicely correlated. Especial attention should be called to Chapters IV. and VIII., and to Art. 27 of the former chapter in particular. Lucid is not too strong to describe some portions of the book. On the whole, readers who want only a general idea of what the theory is about can scarcely find a more concise and clear presentation for that purpose. The numerous, excellent, well-chosen exercises at the end of each chapter will, if solved, greatly enhance the permanent value of the book.

The adverse criticism is herein placed first so that the reader may finish the review with the desire to get and read the book, and find it as interesting and profitable as the reviewer has found it.

Charles C. Grove

ARISTOTLE'S ECHENEIS NOT A SUCKING-FISH

In the course of a rather extensive series of researches on the shark-sucker, it has been

found necessary to trace this fish back to Aristotle, the Father of Natural History, with the interesting result that it has become very evident that Aristotle's *Echeneis* was not a sucking-fish at all.

The first reference in question is in the "Natural History of Animals," Book II., 14; 505 *b*, 19–22; and, as rendered in Professor D'Arcy W. Thompson's scholarly translation (Oxford, 1910), it reads:

> Of fishes whose habitat is in the vicinity of rocks, there is a tiny one, which some call the *Echeneis* or shipholder. . . . Some people assert that it has feet, but this is not the case: it appears, however, to be furnished with feet from the fact that its fins resemble these organs.

A fair acquaintanceship with the sucking-fish and a somewhat extensive reading of the literature fail utterly to substantiate these statements. It is true that, blindly following Aristotle, a number of the medieval writers on natural history, or more properly pseudo-natural history, speak of the *Echeneis* as given to laying fast hold on to rocks at the approach of storms and staying there until the return of fair weather. St. Ambrose in his "Hexameron," written in the fourth century A.D., seems to have been the first to set forth this story of the *Echeneis* as a rock-holder and weather prophet. However, this is plainly an echo of Aristotle and there is no ground whatever, so far as I know, for any such belief, or for thinking that it dwells among rocks.

Further, it is not a "tiny fish." Adult Echeneises run in size from 15 to 36 inches, and adult Remoras from 10 to 15 inches in length. It might be well just here to state that *Remora* is not only the smaller of the sucking-fishes, but is generally of a dark uniform brown color. *Echeneis,* on the other hand, is not only much larger, but is of a slaty-brown or black color, and is easily recognized by the broad black stripe edged with white extending from the angle of the mouth back through the eye along the mid-lateral line to the base of the caudal fin. Both fishes have on the top of the head and on the back-of-the-neck region a haustellum or sucker made up of the modified spinous dorsal fin. This sucker consists of a circumferential rampart of soft tissue forming an ellipse divided into compartments by numerous crosswise partitions and having a single lengthwise partition running from end to end in the longest diameter of the ellipse, which is also the median dorsal line of the fish. This sucker is under muscular control, and when applied flat to an object and then raised a partial vacuum is created and the sucking-fish clings fast.

Last of all, no sucking-fish has fins even distantly approaching the form of feet, the pectoral and pelvic fins being of the ordinary teleostean type and showing no special modification whatever. Many authors have thought that in this last sentence Aristotle was describing an Antennariid fish, of which the Sargassum fish, *Pterophryne histrio,* not uncommon in our waters, is a good example. Such fish have the pectoral fins modified to form organs not superficially unlike a hand. However, in endeavoring to identify Aristotle's fish we must take into consideration his whole description. His fish I believe to have been a goby, for the following reasons: gobies are "tiny fish which live among rocks," and which have their pelvic fins united to form a cup-like adhesive organ, which is placed on the thorax, in order that they may adhere to the rocks among which they live.

In another place, however, Aristotle does refer to a fish which in my judgment is an *Echeneis,* or sucking-fish, though he does not he writes:

> In the seas between Cyrene and Egypt there is a fish that attends on the dolphin, which is called the "dolphin's louse." This fish gets exceeding fat from enjoying an abundance of food while the dolphin is out in pursuit of its prey.

This fish Professor Thompson identifies with the pilot-fish, *Naucrates ductor,* which is represented in our Atlantic coastal waters by the very beautiful little Carangid fish, *Seriola zonata.* This "dolphin's louse," however, I identify as the sucking-fish. The first evidence to be presented is found in the context. This last reference to Aristotle comes in a section given over to a consideration of various sucking parasitic insects, lice, ticks, fleas, etc., and

ends with a description of those crustaceans parasitic on fishes to which the name "sea lice" is given. This internal evidence certainly lends itself to the view that the dolphin's louse was a sucking fish.

In working up the literature, two references of marked interest just here have been found. Hasselquist, the friend and pupil of Linnæus, in his "Reise nach Palæstina" (published in 1762) refers to an *Echeneis neucrates* (an old spelling of *naucrates*) collected at Alexandria and records that the Arabic fishermen there called it *Chamel el Ferrhun*. This term Dr. Frank R. Blake, of the Johns Hopkins University, very kindly translates for me as the "louse of the terrible one"—*i. e.*, a shark.

Another like name is to be found in the writings of another eastern traveller, Forskäl, likewise a pupil of Linnæus. He collected on a shark at Djidda, a town situated about half way down toward Aden on the eastern shore of the Red Sea, an *Echeneis neucrates* which the natives there called *Kaml el Kersh*, and which he translates the "louse of the shark." Dr. Blake kindly writes me that this term is more properly to be rendered "the louse of the fish of prey" (which Forskäl tells us was a *Carcharias* shark). From all of which we see that in the east, where habits and customs and even names change slowly, the sucking-fish was still called "the louse" some 2,000 years after Aristotle.

We now come to the most interesting point of all in this discussion, which is that if one reads Aristotle closely he will be convinced that the Father of Natural History never saw the shark-sucker. Aristotle's descriptions of other fishes are very clear, evidencing keen powers of observation, and it is not to be thought that, having ever seen and examined the sucking-fish, he could have failed to give an explicit description of the sucking disk. Note also that his words are ". . . which some call the *Echeneis* or ship-holder." He is quoting from some one else and in the judgment of the present writer never saw the *Echeneis*.

E. W. Gudger

State Normal College,
Greensboro, N. C.

SPECIAL ARTICLES

ANTAGONISM AND WEBER'S LAW

When toxic substances act as antidotes to each other this action is called antagonism. It is usually found that when antagonistic substances are mixed in various combinations there is one proportion which is more favorable than others. If this favorable proportion be maintained it is well known that considerable variation in the concentration of the antagonistic substances is permissible for many plants. It has been pointed out by the writer[1] that while variations in concentration affect the form of the antagonism curve they do not in general affect the proportions which are most favorable for life processes.

It is therefore evident that if we wish to preserve the favorable character of a mixture when the concentration of any antagonistic substance is increased we must at the same time increase the concentration of the others in the same proportion. The law of direct proportionality found in such cases is in reality Weber's law, as Loeb[2] has pointed out in discussing his experiments on animals. In regard to the significance of this Loeb says:

> Since this law underlies many phenomena of stimulation it appears possible that changes in the concentration of antagonistic ions or salts are the means by which these stimulations are brought about, as suggested by my ion-protein theory and by the investigations of Lasareff.

In view of the importance of these relations it seems desirable to ascertain, if possible, what mechanism exists which makes one proportion better than others and preserves this pre-eminence in spite of variations in concentration.

The writer has formulated a theory[3] involving precisely this kind of mechanism. According to this theory the electrical resistance and the permeability of protoplasm are determined by a substance M which is formed and decomposed by the reactions

$$A \rightarrow M \rightarrow B$$

Under normal circumstances M is formed as

[1] *Botanical Gazette*, 58, 367, 1914.
[2] *Proc. Nat. Acad. Sciences*, 1: 439, 1915.
[3] *Proc. Am. Phil. Soc.*, 55, 1916.

fast as it is decomposed and its concentration remains constant. But under unfavorable conditions the decomposition of M proceeds faster than its formation; this results in injury and, if carried far enough, in death.

The processes which produce this result in such solutions as mixtures of NaCl and $CaCl_2$ are checked by a salt compound[4] of the type Na_2XCaCl_4 formed by the reversible reaction

$$2NaCl + X + CaCl_2 \rightleftharpoons Na_2XCaCl_4,$$

in which X is a constituent of the protoplasm.

The amount of this salt compound formed in each mixture of $NaCl + CaCl_2$ can be calculated by the formula

$$K = \frac{Conc_{Na_2XCaCl_4}}{(Conc_{NaCl})^2 (Conc_{CaCl_2})(Conc_X)}$$

In pure NaCl the amount of Na_2XCaCl_4 will be zero, but if increasing amounts of $CaCl_2$ be added the amount of Na_2XCaCl_4 will increase to a maximum and then decline until it again reaches zero in pure $CaCl_2$.

Let us assume that the maximum amount of Na_2XCaCl_4 is found when the molecular proportions[5] are 95.24 $NaCl + 4.76$ $CaCl_2$. It is evident that we can get this same amount in a different mixture (*e. g.*, 50 $NaCl + 50$ $CaCl_2$) by increasing the absolute concentrations of NaCl or $CaCl_2$. We should therefore get an equally favorable result in both cases: but this is contrary to the results of experiment. If the phenomena of antagonism really involve a salt compound like Na_2XCaCl_4 it is evident that some mechanism must exist which insures that an increase in the total concentration of salts will have little effect as compared with that produced by a change in their relative proportions.

It is easy to see that such a mechanism must exist if the formation of Na_2XCaCl_4 takes place at a surface. In a surface substances usually exist in a different concentration from that which they have elsewhere in the solution. If NaCl and $CaCl_2$ migrate into the surface, so as to become more concentrated there than in the rest of the solution, their concentration in the surface must increase, as their concentration in the solution increases, up to the point where the surface is saturated. Beyond this point an increase in their concentration in the solution produces no effect on their concentration in the surface. When this stage has been reached the formation of Na_2XCaCl_4, if it takes place in the surface, will not be affected by an increase in the concentration of the salts in the solution. It will, however, be affected by changes in the relative proportions of the salts. The number of molecules in a unit of surface will remain nearly constant, but if the proportion of NaCl in the solution be increased some of the $CaCl_2$ in the surface will be displaced by NaCl.[6]

Below the saturation point the relative proportions of the salts will be of less importance than their total concentration: this is the case at low concentrations in the region of the so-called "nutritive effects."

It is evident that if we adopt this theory we can see why the most favorable proportion must remain approximately the same in spite of variations in concentration. We thus arrive at a satisfactory explanation of Weber's law.

It is evident that Weber's law will not apply when the concentration is below the saturation point. On the other hand at high concentrations effects of osmotic pressure, coagulation, etc., may exert a disturbing influence.

Thus far we have discussed effects in which the criterion of antagonism is electrical resistance or permeability. But it has been shown by the writer that electrical resistance and permeability are very accurate and sensi-

[4] The actual proportion of Na and Ca in this compound may be supposed to differ according to the proportion of these substances in the most favorable mixture. In place of Na and Ca we may have other antagonistic salts, and more than two may enter into the compound.

[5] These are the proportions found in an investigation described in *Proc. Am. Phil. Soc.*, 55, 1916.

[6] It may easily happen that NaCl and $CaCl_2$ do not migrate equally into the surface. If we assume that 10 times as much $CaCl_2$ enters the surface as NaCl we shall find the maximum amount of Na_2XCaCl_4 in 95.24 $NaCl + 4.76$ $CaCl_2$. (*Cf. Proc. Am. Phil. Soc.*, 55, 1916.)

tive indicators of vitality. It therefore seems highly probable that the theory here presented may be applied in those cases where other criteria of antagonism (such as motion, growth and length of life) are employed.

It will be seen that action in a saturated surface is the essence of this explanation. It is evident that so long as this essential feature is preserved it makes little difference what theory of antagonism we adopt. If the antagonistic substances act in a saturated surface antagonism must be governed by Weber's law.

Summary.—The fact that Weber's law governs antagonism is explained by a dynamical theory formulated by the writer.

This theory assumes that injury and death result from processes which are inhibited by salt compounds formed by the union of salts with the protoplasm. If these compounds are formed in a surface the amounts will (above a certain limit) be independent of variations in concentration and will depend only on the proportions of the antagonistic salts. From this it results that Weber's law must govern the phenomena of antagonism.

No matter what theory of antagonism we adopt, it is evident that if the antagonistic substances act in a saturated surface antagonism must be governed by Weber's law.

W. J. V. Osterhout

Laboratory of Plant Physiology,
Harvard University

DO FUNGI LIVE AND PRODUCE MYCELIUM IN THE SOIL?

The recent investigations on soil microorganisms have revealed the fact that fungi are found in soils in very large numbers sometimes reaching as high as 1,000,000 per gram of soil. These numbers are found by diluting the soil and then plating out only a small portion of a gram. The colonies developing on the plates represent the spores or pieces of mycelium found in the soil. But this does not tell us about the actual active life of the fungi in the soil. However large the numbers that are found, it remains to investigate whether those organisms existed in the soil only in the form of spores, which were brought in by some outside agency, or are a result of active life in the soil in the form of mycelium which may or may not result in the formation of spores in the soil. The question is not how many numbers and types of fungi can be found in the soil, but what organisms lead an active life in the soil. To what depth are these organisms found to produce mycelium in the soil? And finally, do all or at least most of the organisms isolated from the soil actually produce mycelium in the soil?

At the suggestion of Dr. Charles Thom, of the Bureau of Chemistry in Washington, a direct isolation of fungi producing mycelium in the soil was attempted. Soil samples taken at different depths, under absolutely sterile conditions, were brought into the laboratory; lumps of soil, about 1 cm. in diameter, were transferred with sterile forceps into sterile plates containing cooled sterile Czapek's solution agar. The lump was placed carefully in the center of the dish, which was immediately covered and allowed to incubate for 24 hours at 20–22° C. After this period mycelium was found to radiate out of the lump of soil into the medium. This mycelium was now transferred with a sterile platinum loop to sterile slants of Czapek's agar, care being taken to select the tips of the hyphæ so as not to bring the loop in too close contact with the soil. The agar slants containing the transferred portions of mycelium were allowed to incubate till the organisms had developed well and were ready for study. The organisms thus isolated were not always pure. They had to be often separated from one another; this was accomplished by establishing pedigree cultures of the organisms.[1]

The organisms thus isolated are believed to come from the mycelium that is actually found in the soil. The period allowed for the incubation of the soil in the petri dish was not long enough for spores in the soil to germinate and produce such a mass of mycelium; this is espe-

[1] The methods of isolation and establishment of pedigree cultures, as well as the details of the work, formulæ for media used and identification of organisms will be published later.

cially true, since the medium used for incubation (Czapek's agar) is very unfavorable for the development and growth of the Mucorales, the group of organisms which had most representatives among the fungi isolated by the method previously described.

Organisms Found	Soils Used							
	Garden[2]	Orchard	Meadow	Forest	Iowa	Cranberry	Oregon	Dakota
Mucor plumbeus (Bonorden)	+[3]	+	+	+				
Mucor racemosus (Fres.)	+		+	+		+	+	
Mucor circinelloides (Van Tiegham)	+	+	+	+		+	+	+
Mucor hiemalis (Wehmer)	+		+				+	
Zygorhynchus vuillemnii (Namys.)	+	+	+	+	+			
Rhizopus nigricans (Ehrbg.)		+	+		+	+	+	
Green Trichoderma	+	+		+	+	+		
Penicillium luteum (Zukal)						+		
Penicillium sp.						+		
Fusarium sp.	+		+				+	
Sporotrichum sp.			+					
Acrostalagmus albus (Preuss.)	+						+	
Cephalosporium acremonium (Corda)			+				+	
Zygodesmus sp.							+	
Sclerotium					+		+	+
Sterile White Mycelium	+		+	+	+	+	+	+

To establish the fact whether the mycelium transferred, after the soil was allowed to remain in contact with the sterile medium, came from spores or from mycelium in the soil, the following test was made. A series of sterile plates containing cool, sterile Czapek's agar were incubated with spores and portions of mycelium from several organisms. The spores were had by shaking some spore material with 50 c.c. sterile water, then dipping a sterile platinum needle into the liquid and passing it over the surface of the sterile medium, thus dropping the single spores. The mycelium was transferred directly with a sterile needle from the culture upon the plate. The organisms used for this test were several Mucors, Trichodermæ and Penicillia. After twenty-four hours' incubation at 20–22° C. the plates were examined. Those that were inoculated with the mycelium had quite an extensive growth, the tips of the hyphæ being about as distant from the center of inoculation as in the case where the soil was used as an inoculum. But on the plates where only spores were inoculated very minute colonies could be observed with the naked eye; upon placing the dish under the microscope and examining it with the low power, one could see these colonies forming from each spore along the trace left by the needle in the medium. This fact gave reasons to believe that the mycelium developing on the plates from the soil came not from spores, but from organisms that actually live in the soil and produce mycelium there.

A number of soils of different origin, of different physical and chemical composition and treatment, were used for this investigation. The following table shows the occurrence of the different organisms in the soil, in the form of mycelium.

The results brought out in the above table are very interesting. Soils of entirely different textures, chemical and physical composition, soils widely apart from one another, contain many organisms which are alike for several of them. Of course, this refers only to the organisms that have been isolated by the above method and in the few soils studied. Other soils may contain different groups of organisms, as is found in the case of the Iowa and Dakota soils, where only very few organisms have been isolated by the direct method. It looks as if soils that are under a relatively similar range of conditions show, to a certain extent, similar groups of organisms when these are isolated directly from the soil.

Mucor circinelloides, Zygorhynchus Vuilleminii, green *Trichoderma, Rhizopus nigricans* and *Mucor racemosus* were found most abundantly. The *zygorhynchus* has been found at all depths from one to thirty inches below the surface, while most of the other organisms were isolated from the upper eight inches of soil. In most samples taken at depths of 12, 20 or 30 inches only *zygorhynchus* would develop from the soil upon the plate, with no other organism. The *sterile white mycelium*

[2] The garden, orchard, meadow and forest soils came from the College Farm, New Brunswick, N. J., Cranberry from Jamesburg, N. J., the other four soils from the respective station grounds.

[3] Indicates presence of organism.

developing from most of the soils is probably the mycelium of fleshy fungi. Other organisms, such as the *Penicillia, Fusaria* and *Sporotricha,* which are usually found in the soil abundantly when plated out by the dilution method, have been isolated by this method only in very few cases. The *Aspergilli, Alternaria, Cladosporia,* the great majority of the *Penicillia,* and other organisms commonly found in the soil, have not appeared on the plates in twenty-four hours, when the soil has been inoculated directly upon sterile medium.

Selman A. Waksman
Agricultural Experiment Station,
New Brunswick, N. J.

THE AMERICAN CHEMICAL SOCIETY.

IV

DIVISION OF WATER, SEWAGE AND SANITATION

Edward Bartow, *Chairman*

H. P. Corson, *Secretary*

Sanitary Surveys as a Feature of Public Health Work: H. E. Barnard.

Sanitary Survey Methods: J. C. Diggs.

A Sanitary Survey of Logansport, Ind.: J. C. Diggs.

Swimming Pool Sanitation: W. Lee Lewis.

The Rate of Ammonia Distillation in Water: F. W. Bruckmiller.

A Modification of the Whipple Method for Direct Nesslerization: F. W. Bruckmiller.

The Determination of Carbonic Acid, Combined and Free, in Water: John Johnston.

The Numerical Treatment of B. coli Values in Water Analysis: Earle B. Phelps and William F. Wells.

Development at Lawrence of the Process of Purifying Sewage by Aeration and Growths—Activated Sludge: H. W. Clark.

This paper describes the discovery and development at the Lawrence Experiment Station of the Massachusetts State Department of Health of the method of purifying sewage by aeration and growths—a method known quite generally as the activated sludge method. The paper shows that the method was developed there in 1911 and 1912, was shown to Dr. Gilbert Fowler, of Manchester, Eng., in the fall of 1912 and that the English work was largely a repetition of the Lawrence work. It quotes from Fowler and from Ardern and Lockett, his colleagues, to prove that their activated sludge work was based upon the Lawrence work. The paper further gives the statement of Dr. McLean Wilson, of England, made in his presidential address to the Association of Sewage Works Managers. This statement is as follows:

Many investigators, including Drown, Dupre and Dibdin, Mason and Hine, Black and Phelps, Fowler and others, had sought to purify sewage by direct chemical oxidation by means of air currents and had failed. At Lawrence, however, the efficiency of growths in the purification of sewage by aeration was discovered.

The paper further describes the Lawrence work during the past four years and the results of much of this work. These results show that sewage can be fairly completely purified by this method. The paper is concluded as follows:

Finally, the governing factors in the success of this process of sewage treatment are, as I have stated in previous articles: (1) The cost of power for supplying the large volume of air necessary; (2) a sewage that readily yields itself to this method of treatment. It is not impossible to believe that certain sewages can not be purified in this manner.

Composition of the Effluent Air from an Activated Sludge Tank: F. N. Crawford and Edward Bartow.

Experiments with Activated Sludge at Milwaukee, Wis.: W. D. Copeland.

The Aeration of Sewage in the Presence of Activated Sludge from the Standpoint of an Engineer: E. J. Fort.

Activated Sludge Experiments at the Baltimore Sewage Disposal Plant: Calvin W. Hendrick.

Chemical Observations of the Activated Sludge Process as applied to Stock Yards Sewage: Arthur Lederer.

The Activated Sludge Process: W. D. Richardson.

The Sewage Experiment Station of the Illinois State Water Survey: J. F. Schnellbach and Edward Bartow.

The Experiments with Activated Sludge at Brockton, Mass.: Robert Spurr Weston.

Brockton, Mass., population 62,000, discharges an average of 2,100,000 gallons fine-screened sewage daily, two thirds on 30 acres of sand beds, one third on 0.5 acre trickling filter, followed by 7 acres of sand beds. Rates are low; efficiency also. Difficulty due to stale, strong sewage containing shoe factory waste and dyes. (Suspended solids 204, free ammonia 55.8, chlorine 138.6 p. p. m.) Plain aeration with and without contact followed by Imhoff tank and trickling filter treatment was tried in 1915 with unsatisfactory results. More aeration was required. Fill and draw activated sludge tank followed by sand bed at 500,000

gallon rate gave excellent results. Continuous process now being tried for clarification alone. Results good. Aeration period at least four hours. Complete nitrification never obtained by aeration even after 25 days. Nevertheless, activated sludge process alone offers relief to present overtaxed plant.

Some Results on the Treatment of Packing House Sewage by the Aeration Process in the Presence of Activated Sludge: PAUL RUDNICK AND G. L. NOBLE.

The Saving Effected by Using a Softened Water in Boilers: G. S. COTTER.

The Treatment of Industrial Wastes: HARRISON P. EDDY.

Some Studies on Chemical Self Purification in the Ohio River: EARLE B. PHELPS AND HAROLD W. STREETER.

Oxygen Demand Determination in the Field: F. W. BRUCKMILLER.

The Determination of Nitrates in Sewages by the Ortho-Toluidine Reagent: EARLE B. PHELPS AND H. L. SHOUB.

Studies on the Removal of Manganese from Water Supplies: H. P. CORSON AND EDWARD BARTOW.

The Value of Softened Water to a Railroad: R. C. BARDWELL.

Softened Water and Its Benefits in Laundry Work: JOHN H. RYAN.

Some Features of Swimming Tank Control: W. LEE LEWIS.

The American literature offers very little direct data on the epidemiology of swimming pools, though there is general expression to the effect that such pools may spread gastro-intestinal, respiratory and even venereal diseases if improperly controlled. The rotating or continuous filtration system maintains a more sanitary pool than intermittent filling. Both should be supplemented by daily sterilization. Pool water of Lake Michigan type, as shown mathematically and experimentally, should not be rotated under the conditions more than three months on account of decreasing alkalinity and increasing hardness.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Irving Langmuir, *Chairman*

James Kendall, *Secretary*

The Chromic-Chromous Potential at Mercury Electrodes: GEORGE SHANNON FORBES AND H. N. RICHTER. (Lantern.)

Pure violet $CrCl_3$, partially reduced to $CrCl_2$ by purified hydrogen at 400° in quartz, was dissolved with stirring in ice-cold, tenth normal hydrochloric acid. The solution, filtered into the cell, was allowed to stand over pure mercury. If all operations were conducted in hydrogen or carbon dioxide absolutely free from oxygen, the potential rose throughout two days to a constant maximum, otherwise it fluctuated irregularly. Concentrations at equilibrium were determined analytically. Referred to normal hydrogen electrode as zero, with correction for junction potentials,

$$\pi = -0.400 + 0.065 \log Cr^{III}/Cr^{II}.$$

On platinum potentials reached a maximum about 0.16 volt lower, with evolution of hydrogen.

Heterogeneous Equilibria between Aqueous and Metallic Solutions: A Study of Mixed Sodium and Potassium Salt Solutions at Total Concentrations varying from 0.2 N to 4.0 N: G. MCPHAIL SMITH AND T. R. BALL. (Lantern.)

The Contamination of Precipitates in Gravimetric Analysis: Solid Solution and Adsorption vs. Higher-Order Compounds: G. MCPHAIL SMITH.

An Electrically Controlled Calorimeter for Measuring Heats of Dilution: D. A. MACINNES AND J. M. BRAHAM. (Lantern.)

On the Evolution of the Elements according to the Hydrogen-Helium System: W. D. HARKINS. (Lantern.)

Theoretical Relations of the Atomic Weights: W. D. HARKINS. (Lantern.)

A New Gravimetric Method of Determining Aluminum, and of Separating that Metal from Zinc, Manganese, Nickel, Cobalt, Iron and Chromium: LOUIS KAHLENBERG AND K. P. YOUNG.

When ammonium salicylate is added to a dilute solution of an aluminum salt, and this solution is then boiled, there separates out in granular form a basic aluminum salicylate of the composition $(Al(C_6H_4 \cdot OH \cdot COO)_3)_2 \cdot Al(OH)_3$. This may be readily filtered off, washed with hot water, ignited and weighed as Al_2O_3. The precipitate is much more readily handled than the usual slimy and gelatinous precipitate of aluminum hydroxide. Zinc, manganese, nickel, cobalt, ferrous iron and chromium are not thus precipitated by ammonium salicylate, which fact is the basis for the direct and simple separation of these metals from aluminum. The solution should be fairly dilute, lest the basic aluminum salicylate occlude notable amounts of the other metals. If this should occur, redissolving the precipitate and then reprecipitating from the dilute solution will secure a good separation. Sodium salicylate may be used as the

precipitant instead of ammonium salicylate, but the latter is preferable.

The Electromotive Forces of Concentration Cells and their Relation to the Transference Number: D. A. MacInnes.

The Complete Solubility Curve of Calcium Carbonate: John Johnston.

The Specific Conductivity of Pure Water in Equilibrium with Atmospheric Carbon Dioxide: James Kendall.

An Apparatus for Determining Freezing-Point Lowering: R. G. Van Name and W. G. Brown.

The Colloidal Phosphates and Arsenates of Iron: Harry N. Holmes.

The Formation of Crystals in Gels: Harry N. Holmes.

The Potential of Iodine Concentration Cells: Grinnell Jones.

A Supposed Effect of the Form of Container upon the Density of a Gas: William A. Noyes and Laurence C. Johnson.

In an effort to explain the difference in the volumetric ratio of hydrogen to oxygen in water as determined by Morley and by Scott, the volume occupied by a gas in a system of tubes has been compared with that occupied by the same mass of gas in a bulb. It has been shown that there is no difference in volume larger than one part in ten thousand, whereas the two determinations referred to differ by one part in one thousand.

A Demonstration of the Selective "Action" of Clay on Soluble Sulphides: John C. Ingram.

The Theory and Mechanism of Adsorption: Irving Langmuir.

The Oxides of Iron. II. Magnetic Properties of the System Fe_2O_3-Fe_3O_4: R. B. Sosman and J. C. Hostetter.

The Dissociation of Ferric Oxide in Air: J. C. Hostetter and R. B. Sosman.

On the Measurement of the True and Apparent Electrical Conductivities of Solutions: Inductance, Capacity, Frequency and Resistance Relations: H. P. Hastings, W. A. Taylor and S. F. Acree.

Separation of the Elements of the Tin Group: J. M. Welch and H. C. P. Weber.

A very characteristic combination of tin and antimony sulfide, which is always formed when tin and antimony are precipitated together, is utilized as an indication of the presence of these two elements. The compound formed, which is probably a salt of thioantimonic acid, has not been isolated as yet, but a few compounds of the type are known. The reaction is characteristic for all mixtures of tin and antimony lying between 1:20 and 20:1.

The procedure consists in obtaining this brown-black color reaction, redissolving the sulfides without separation, precipitating the antimony as sulfide from an oxalate solution and reducing the stannic chloride in the filtrate to stannous chloride with metallic lead.

The process described is shorter and its use by students has resulted in a material decrease in the number of errors (as shown by statistics) in the work done.

Differential Iodimetry. III. Determination of Vanadium in the Presence of Iron and Uranium: O. L. Barnebey.

Differential Iodimetry. II. Determination of Chromium in the Presence of Iron: O. L. Barnebey.

Precipitation of Magnesium Ammonium Orthophosphate: Edward G. Mahin.

Some Laboratory Experiments on the Extraction of Radium from Carnotite Ores: A. G. Loomis and Herman Schlundt.

A System for Reports on Quantitative Analysis to be used in Teaching: E. Gill.

The Action of Anhydrous Aluminium Chloride upon Unsaturated Hydrocarbons: W. E. Henderson and W. C. Gangloff.

The Determination of Solubility Curves by the Method of Flotation: W. E. Henderson and Gebhart Stegeman.

Determination of Transition Points by the Measurement of Electromotive Force: W. E. Henderson and I. W. Geiger.

A Systematic Procedure for the Separation of the Anions: First Group: H. A. Winckelmann and H. C. P. Weber.

The problem of the systematic separation of acids, which has received very little attention in analytical methods, is an especially important one in connection with instruction in chemistry, and possibly of more importance generally than is realized. Actually, very little has been done in the subject.

By means of the plan outlined mixtures containing any or all of the radicals, ferrocyanide, ferricyanide, cyanide, thiocyanate, chloride, bromide, iodide, sulfide, in quantities varying from 0 to 100 mg. may be satisfactorily analyzed, and their amounts estimated. The steps can not well be presented in abstract, but the manipulations are the customary ones of qualitative analysis, the

successive reagents being zinc salts, silver salts, mercuric salts, alkaline formates, metallic copper and cuprous salts.

On Some Molecular Compounds in Glass: E. W. TILLOTSON.

On the Variable Rotatory Power of Dissolved Organic Substances: M. A. ROSANOFF AND H. A. MORTON.

On the Constant a of Van der Waal's Equation: M. A. ROSANOFF AND H. C. CORLISS.

On the Change of Transition Points with Pressure: M. A. ROSANOFF.

A Rational Process of Fractional Distillation: M. A. ROSANOFF.

A Study of Some of the Physical Properties of Mixtures of Dielectric Oils and Water. (Preliminary Report.): L. I. SHAW AND L. A. PAPPENHAGEN.

Change of Conductivity with Time in the System MeOH + I_2. (Preliminary Report.): L. I. SHAW AND J. P. TRICKEY.

Atomic Weight of Yttrium: C. W. BALKE AND B. S. HOPKINS.

The Potassium Iodide Reaction for Platinum: W. J. PRINCE AND H. C. P. WEBER.

The cherry-red, to rose, tint which is produced in platinum solutions by means of potassium iodide is one of the most sensitive tests known. Apparently well-suited for the purpose of colorimetric estimation of the quantity of platinum in solutions, the reaction has not been used for this purpose for lack of ability to properly control conditions.

This investigation shows that the resulting color is not the result of the formation of a reduction product, such as a platinous compound or of colloidal platinum. There is an intermediate formation of a complex iodide, and the water plays an essential part (hydrolysis) in the reaction since the color is not developed in certain other solvents. Immediately after development of maximum color intensity has been attained a colloidal phase can be distinguished in the ultramicroscope, but this is platinum iodide. The rate of the reaction is affected enormously by the quantity of KI present. If only theoretical proportions of this substance are added (6KI: 1 Pt) the reaction goes almost directly to black colloidal PtI_4. The reaction curves show that 4 to 5 times the theoretical quantities of KI are necessary to produce satisfactory results. As little as 2×10^{-7}g. Pt may be recognized in 1 c.c. of solution.

From consideration of the optimum conditions necessary for the production of the desired color reaction it is hoped that a colorimetric method for the estimation of Pt may be developed.

The Viscosity of Alcoholic Solutions: O. F. TOWER.

The Relation between Molecular Cohesion and Surface Tension. Eötvös Law: ALBERT P. MATHEWS.

Determination of Aluminium as Oxide: WILLIAM BLUM.

The various factors affecting the precipitation, washing and ignition of aluminium hydroxide in quantitative analysis were studied. By means of the hydrogen electrode it was found that the precipitation is complete at a point between the turning points of the indicators methyl red and rosolic acid, the use of which is therefore recommended. The conditions for the accurate estimation of aluminium are defined.

A Study of Tantalum Pentachloride for Atomic Weight Purposes: G. W. SEARS AND C. W. BALKE.

A Study of the Dialysis of a Colloidal Solution of Hydrous Chromic Oxide in Chromium Chloride: MARKS NEIDLE AND J. BARAB.

The Temperature Effect in Dialysis, and a Simple Rapid Dialyzer: MARKS NEIDLE.

Production of Triatomic Hydrogen by Radium Rays: G. L. WENDT.

The Effect of Dissolved Substances on the Velocity of Crystallization of Water: J. H. WALTON AND A. BRAUN. (Lantern.)

The Atomic Weight of Dysprosium: C. W. BALKE AND E. W. ENGLE.

Dysprosium material was purified by the alkali sulfate separation, followed by fractional crystallization of the bromates, ethylsulfates and nitrates. For the atomic weight determinations the oxide-chloride ratio was studied. Dysprosium oxide, Dy_2O_3, was placed in a tarred quartz flask, weighed, dissolved in HCl, and the chloride dehydrated, fused and weighed in the flask. Five consecutive determinations gave the values 164.354, 164.357, 164.116, 164.104, 164.207. Mean value 164.228. This is considerably higher than the value now in the International Table.

Potassium Lead Tartrate: R. S. DEAN.

The Density of Aqueous Copper Sulphate-Sulphuric Acid Solutions: H. D. HOLLER AND E. L. PEFFER.

The densities of solutions of copper sulphate and sulphuric acid varying in concentration from 0 to 20 per cent. of each solute, were determined at 25° and 40° C. The densities were found to be approximately additive, and to be dependent upon the total concentration of the two solutes.

An Electrical Insulating Material for Use in Moist Atmospheres: Edward W. Washburn.

Types of Wheatstone Bridges for Alternating Current Work: Edward W. Washburn.

Induced Reactions in the Analytical Chemistry of Lead: V. H. Gottschalk.

An Attempt to Combine Nitrogen and Chlorine Directly: B. R. Honovski, L. C. Johnson, F. O. Anderegg and W. A. Noyes.

Pure nitrogen and chlorine are sparked in a glass apparatus, using gold tipped electrodes. Results vary from 0.2 mg. to 1.5 mg. of combined nitrogen on Nesslerizing. These values were checked by blank analyses at all times.

The Nernst Integration Constant in Gaseous Systems: N. Howell Furman.

Attention is called to the fact that owing to the lack of sufficient data concerning the specific heats of solids over wide range of temperature, and the absence of such data in the case of liquids, the rational vapor pressure formula,

$$lu\pi = -\frac{\lambda_0}{RT} + \int \frac{1}{RT^2}\,dT \int [\epsilon_p - c]dT + i,$$

can rarely be applied to the interpretation of vapor pressure measurements.

The Nernst approximation formula,

$$\log \pi = \frac{\lambda_0}{4.571T} + 1.75 \log T - \frac{\epsilon}{4.571}\,T + c,$$

is more generally applicable, but care must be exercised in its employment, otherwise the values deduced for the several constants will not possess any physical significance whatever.

These points were illustrated by numerical calculations.

The Reactivity of Acids: Hugh S. Taylor.

The Specific Heat and Specific Kinetic Energy of Elements and Compounds: J. E. Siebel.

After devising formulæ for the specific molecular kinetic energy increase, the author determines this and corollary quantities for representatives of different groups of gases and vapors. The tabulated results demonstrate the constancy of their molecular kinetic energy against the inconstancy of their molecular heat (Dulong and Petit product); they also yield the molecular velocity in harmony with Millikan's number of molecules, the relation of molecular velocity to sound propagation, the equivalent of volume- and kinetic-energy, etc. Accordingly these quantities appear as functions of the rectilinear, progressive motion of the molecules not dependent, that is not directly so, on other intermolecular-latent-disgregation- or rotary-energy.

Vapor Pressures of Ethyl Alcohol and Alcoholic Water Mixtures at 25° and Composition of Vapors in Equilibrium with the Mixtures: I. H. Derby and F. Daniels.

Composition Dissociation in Concentrated Solutions of Sodium Chloride and Potassium Chloride: I. H. Derby, D. Mayard and E. T. Fegon.

The Dissociation Pressures of Various Salt Hydrates and the Vapor Pressures of their Saturated Solutions: I. H. Derby and V. Yngve.

The Swelling of Rubber in Various Liquids and the Nature of the Process: I. H. Derby, P. D. Schultz and O. D. Cunningham.

A Study of 0.1 Normal HCl Calomel Electrodes: N. E. Loomis.

Division of Pharmaceutical Chemistry

John H. Long, *Chairman*
Geo. D. Beal, *Secretary*

The New Features of the U. S. P. IX.: Joseph P. Remington. (Lantern.)

The Toxicity of the Volatile Principles of Coffee, with Comments on Coffee Substitutes: L. E. Sayre.

The Pancreatin Tests of the Pharmacopœia: J. H. Long.

Bennett: A Note and a Correction: Howard T. Graber.

Pepsin: A Résumé of Tests: Howard T. Graber.

Relative Toxicity of Different Species of Digitalis: Robert A. Hall, E. L. Newcomb and R. E. Morris.

On the Apparent and Real Ash Content of Digitalis: Norbert Mueller and Edward Kremers.

Alkaloidal Assay by Immiscible Solvents: H. F. Lewis and G. D. Beal.

The Preparation and Characteristics of Emetine: Frank O. Taylor.

Some Unexpected Reactions in Pharmaceutical Mixtures: Frank O. Taylor.

The Strength of Fluid Extracts: H. A. Langenhan and Edward Kremers.

On Tincture of Peppermint for Coloring Purposes: Norbert Mueller and Edward Kremers.

Further Notes on the Identification of the Emodin-containing Drugs: Ruth E. Okey and G. D. Beal.

Determination of Small Amounts of Water and Alcohol in Ether for Anesthesia: E. Mallinckrodt, Jr.

The Detection of Minute Quantities of Unsaturated Hydrocarbons in Liquid Petrolatum: C. H. Briggs and W. L. Irwin.

Charles L. Parsons,
Secretary